

# TALKING ELECTRONICS®

THE LEARNING MAGAZINE

**\$1.20\***

N.Z. \$1.40

**WIN A MULTIMETER!**

... see our contest inside

**Issue No 5.**



**MONOPOLY**

**4 DIGITAL PROJECTS**

**LM380 AMPLIFIER**

**LED DICE**

**Plus a new series on:**

**DESIGNING YOUR OWN POWER SUPPLIES**

WITH REALISTIC 'TUMBLING' ACTION

# TALKING ELECTRONICS

**Editorial... Vol.1 No.5**

I'm happy to say our policy is working. We have penetrated the market very successfully with the magazine and reached a large percentage of schools and radio clubs. From some of our mail we have become aware of one major omission in the social side of electronics. There is a growing need for electronics clubs catering for hobbyists interested in ELECTRONICS IN GENERAL. Up to now you had to be interested in amateur radio or CB or computers and these clubs tended to exclude a large percentage of experimenters. Radio clubs in schools or Scout groups cater for the young but we are finding older people (even retired) are wanting to add to their knowledge. And they have no-where to meet. Electronics has a jargon all of its own and words such as "pf, mfd, cap and tranny" must be spoken to understand how they are sounded. Most electronic hobbyists are gregarious. They like to discuss their interests. But to date they have been denied this opportunity. With our voice and coverage I hope we can rectify this. Our initial task is to generate interest in group meetings all over the country. Beginning by postal contact we would like you to write in to us so that we can organise a CLUB ROLL. This has proved popular with other hobby clubs and I hope it can work for us. Let's see what develops. Cheers,

*Colin Mitchell.*

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### Our Cover Photo

A game of Monopoly is fun. It's a lot more fun when you play it with your own electronic dice. Our Photographer Kevin Poulter brought out his set from the back of the games cupboard when he heard we had a dice project this issue.

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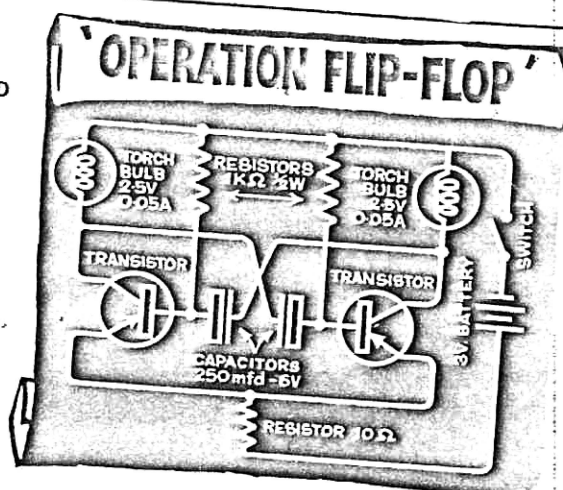
# THE TRIGGER PULSE



AMALGAMATED  
WIRELESS  
VALVE CO.  
PTY. LIMITED

## TRANSISTOR PROJECT

Conducted in conjunction with the  
"SCIENCE IN THE DEVELOPMENT  
OF AUSTRALIA EXHIBITION"  
PRESENTED BY THE  
SCIENCE TEACHERS' ASSOCIATION  
OF VICTORIA  
EXHIBITION BUILDINGS  
AUGUST 7th-AUGUST 15th, 1964

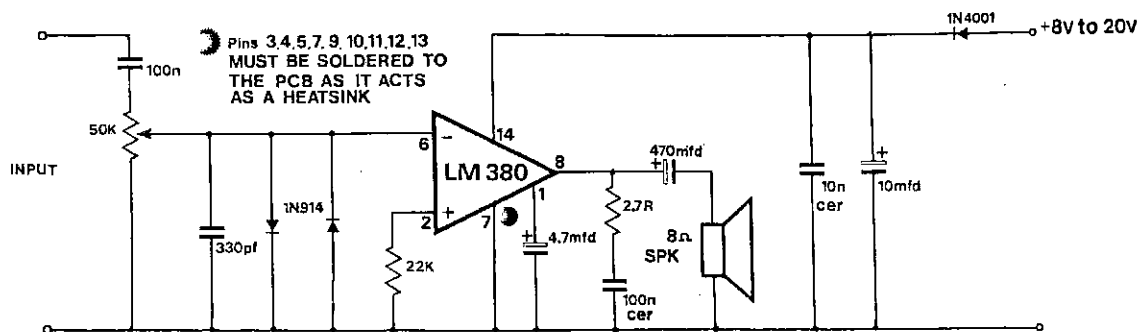


It possibly happens only once in a lifetime. Something completely unexpected occurs to change your course for the rest of your life.

It happened to me on 10th August 1964. I have a card to prove it. I was casually walking around the Exhibition Buildings taking notice of the highly sophisticated displays when I came across the AWW stand. FREE transistors were being given out. Now to give out such precious devices in those days was really a novel occurrence. You see, transistors just a few years prior were costing about \$3.30 for the simple equivalent to a BC 557. So when I saw TWO free transistors I was quite excited. It would be like micro-chips being handed out by Dick Smith at a grand opening. Not only were the transistors good, marked devices, but the accompanying card contained a suitable simple circuit diagram. Up to this time, most of the circuits I had built were centered around radios and amplifiers. This was the first time a flip-flop had been presented to me. This was the turning point of my whole career. The fact that transistors could be used for exciting self-contained projects to operate lamps and relays opened up a completely new horizon. The possibilities of electronics immediately expanded. I was very narrow in my thinking because electronics had never been properly explained. The thought of oscillators, flip-flops and trigger circuits became infinitely more challenging than radio. Not only were the circuits simpler and completely portable but they could be altered and adjusted to operate so many devices. No longer would I be tied down to pumping a speaker or clamping on a pair of headphones. After experimenting with the flip-flop for hours and hours, I went on to make up more complex circuits. Some of my early achievements included the control of venetian blinds to make them open and close automatically, according to the brightness of the day, actuating mechanisms to lock and unlock the back door to my workshop, water level monitoring and rain alarms to help mum with the washing (we didn't have a tumble dryer then), voice operated relays and burglar alarms and a few more of which I only have a brief recollection. The circuits were generally based on standard blocks called "building blocks". Most of these had names and what's more appropriate than naming them after the inventor. Thus we have such names as Hartley oscillator, Schmitt trigger and darlington pair. Some sectors of electronics haven't changed, others have altered radically. The introduction of Integrated Circuits has created the most noticeable change however building blocks are still with us and the designers names are still current. The fun and enjoyment of electronics is still solidly available. The chip has considerably increased the range and possibilities of electronics and makes former unreachable projects become economic. Looking back, I think I can give a great deal of credit to AWW. I doubt very much if I would be so involved with electronics if it were not for this incident. Who knows, maybe a similar change of direction will occur for you. It could come from a career's night, a friend, school or even this magazine. If it hasn't quite clicked yet - be patient, at any time you could experience a current version of the excitement I felt way back in 1964.

# SIMPLICITY AMPLIFIER

By R. Mallor



As the name implies, this amplifier is simplicity itself. It requires only 13 components around a single chip to deliver about 2 to 4 watts into an 8 ohm speaker. It can be connected to a 1 amp power supply as described in issue 3 or powered by a couple of lantern batteries. Ideally it should be operated on 20 volts and the ratings are all determined at this voltage. As you will see by the table, the power drops off appreciably with voltage and becomes almost transistor-radio power at 9 volts. If you intend to use the amplifier as a "bench amplifier" on 9 volts, it may be feasible to incorporate a 216 battery into the case and keep the whole unit very compact. From our knowledge of the life of a 216 battery, you will be looking at about only 10 to 15 hours life. This will be OK if you intend to use the amplifier for test purposes or for trouble shooting other amplifiers or testing pre-amplifiers. For any other applications, we strongly recommend a regulated power supply.

## THE LM 380 IC

The amplifier is based on National's LM 380 dedicated operational amplifier. The printed circuit board may seem unusual with the large amount of copper still left on the board. This copper acts as a very efficient heat sink. The heat generated in the chip passes through the centre pins and into the copper. This idea is a great improvement over the heat fin required by most other IC's and it is cheaper, simpler and creates a more compact module.

We have not described a case for the amplifier as it will fit into a number of boxes. With a little squeeze, one of our testing staff managed to fit it into a cassette case. This means it will take up very little room and can be put away like an audio tape. If you intend to use the amplifier as a piece of test equipment this compactness will be appreciated. Depending on the size of case you choose, the attachment of leads can be either via wire-wrap pillars or direct soldering. The other ends of the leads should be fitted with alligator clips, colour-coded according to their function. The board is designed to fit into a UB3 jiffy box and in this case the 50k trim pot would be replaced by a regular 50k pot and the switch mounted on the end of the box. If a self-contained bench amplifier is required, a speaker can be fitted into the box leaving just enough room for a 216 battery.

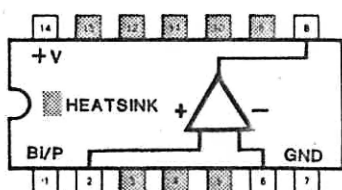
## HOW THE CIRCUIT WORKS

The 100nF capacitor blocks any incoming DC from biasing the LM 380. The signal is then fed to a 50k pot which picks off a percentage of the input signal via the wiper and acts as a volume control. The two input diodes render the input virtually destruction-proof. You can attach the amplifier to virtually any unknown signal source without damaging the LM 380. The diodes conduct at about .6 to .7 volt and shunt any high amplitude signals to earth. The 22k resistor connects the non-inverting input to earth - approximating the input pot in its mid position. Internal stabilization is provided by the 4.7mF electrolytic



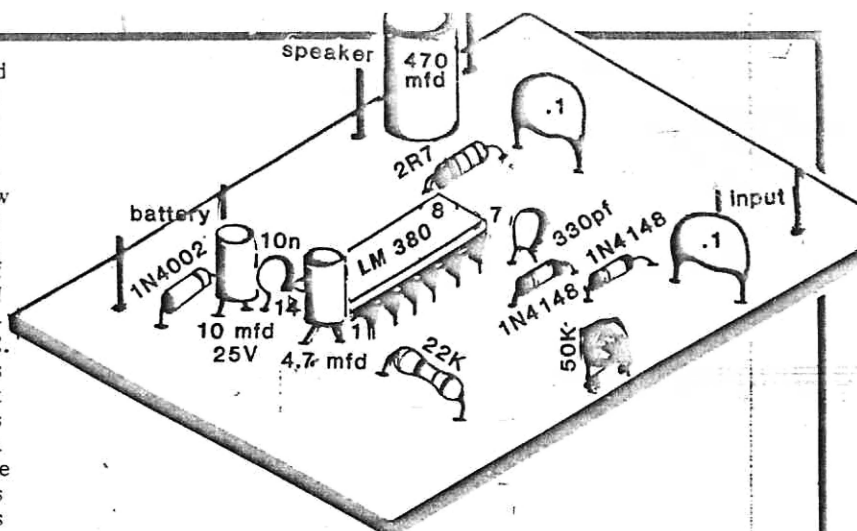
on pin 1. Across the output we have added a 2.7 ohm resistor in series with a 100n capacitor to shunt any high frequency oscillation to deck. DC blocking to the speaker is provided by the 470 mfd electrolytic. It has a high value to pass the low frequency signals. The 10n and 10mfd capacitors provide power supply smoothing and their value will depend on the type of power supply you intend to use. The 1N4001 diode in the positive line will prevent reverse voltage from damaging the IC. Since about .6 volt is dropped across this diode, the amplifier will only see about 7.4 volt when the supply voltage has dropped to 8 volts. This will only give a very low output and may even create some instability. The ideal operating voltage is between 12 and 20 volts and this is where the output begins to deliver 1 watt up to a maximum of 4 watts without clipping. Referring to the performance table you will see these values represent power into the speaker and taking the efficiency of the amplifier into account, the wattage required to be dissipated by the chip is between 3 and 9 watts. Looking at the thin copper heatsink you may be wondering about the temperature rise to achieve this dissipation. We have omitted to say that the ratings only occur for very short periods of time under normal circumstances. This being during very loud passages of music. If the chip were subjected to a continuous high amplitude waveform, it would not last 2 minutes. So don't expect to amplify heavy passages without paying attention to the heat sinking requirements.

Our 1 amp (or 4 amp) power supply is capable of supplying a maximum of about 16-18v from the regulator and will be ideal for supplying the amplifier. We have already mentioned the alternate choice of



LM 380 Pinout

SUPPLY VOLTS	WATTS into 8 ohm spkr	RMS VOLTS at spkr	RMS millivolts at input	Average supply current
20	4	5.66	113.1	636
13.8	1.5	3.47	69.3	390
12	1.0	2.38	56.6	318
9	.35	1.77	35.3	200

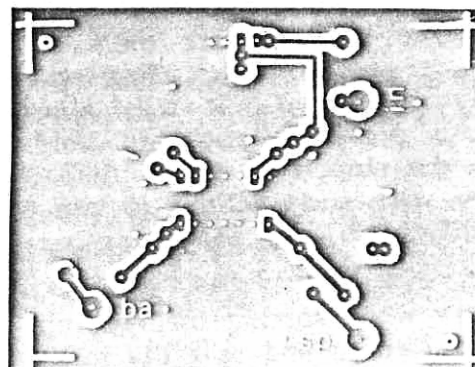


### PARTS LIST

R1	resistor	22k	1/4 watt
R2	"	2R7	"
RV1	trim pot	50k	
C1	capacitor	100n	ceramic
C2	"	330pf	styro
C3	electrolytic	4.7mfd	16v
C4	capacitor	100n	ceramic
C5	electrolytic	470mfd	16v
C6	capacitor	10n	ceramic
C7	electrolytic	10mfd	16v
D1,D2	diode	IN 914, IN 4148	
D3	"	IN 4001	
IC1	Audio Amp.	LM 380	
4 square wire wrap pins			
SIMPLICITY AMP PC Board			

### Additional components:

- 1 - UB 3 Jiffy box
- 1 - 50k log pot and knob
- 2 - 3.5mm sockets
- 1 - 56mm mini speaker 4 ohm or 8 ohm
- 1 - length of single core shielded cable
- 1 - battery clip for 9v battery
- 1 - power supply @ 20v 1 amp
- 1 - set of alligator clips and leads



supplies and the final decision will depend on portability and cost.

The LM 380 itself is very compact and lends itself to making a very low profile amplifier. By laying the electrolytics on their side, the amplifier will fit into a cassette case.

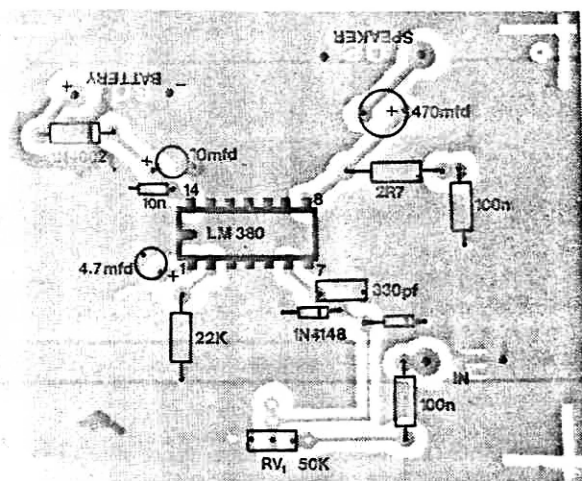
4 watt delivery from a normal 14 pin IC is quite an achievement and National have produced a very versatile amplifier. It has been produced specifically for consumer products such as tape recorders and portable record players however it can be put into a circuit for experimenting as it requires no special external components.

### MOUNTING THE PARTS

Construction must be carried out on the printed circuit board as designed by the author since it provides the necessary heatsinking. The printed circuit looks very simple but it can be deceptive. You have to be very careful when locating each component so that you get it in the right holes. With the large amount of copper on this printed circuit board, it will tend to heatsink the soldering iron at every connection. This means that you will have to be very quick when making a solder joint as the iron will cool very quickly. We suggest a high wattage iron (over 30 watt for this project so that no dry joints are created. Keep the soldering times short and wait for the soldering iron to heat up fully before making a connection. Start with the resistors, capacitors, diodes, electrolytics and finally the LM 380 integrated circuit. Use your fingers on each of the components to heat-sink them so that they do not get too hot. This applies especially to the IC. It will take any temperature providing you can hold your finger on the chip. Use either jumper leads or square wire-wrap pillars to connect the amplifier to the input, output and supply.

Use a 9v battery when setting the unit up. Switch the amplifier on and test the input with your finger to detect any stray hum. Once you are satisfied it is drawing the correct current, you can connect it to a

larger supply. On full voltage you will be surprised how powerful this amplifier can be. Now let's hope it works for you.



**Simplicity Amplifier layout.**

**Note the 6 wire-wrap pillars**



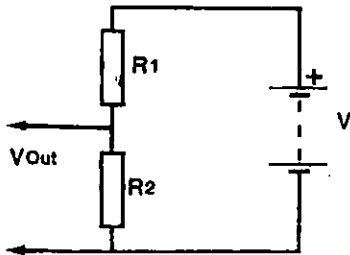


# BASIC ELECTRICITY

## PART 3

### THE VOLTAGE DIVIDER

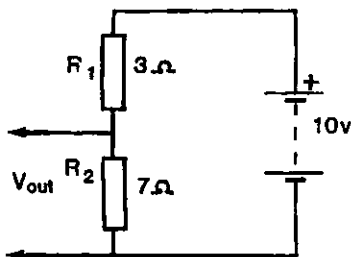
A voltage divider provides LOW voltage out from a HIGHER supply voltage.  
A simple voltage divider uses two resistors as shown:



The voltage  $V_{out}$  is equal to the voltage drop across  $R_2$

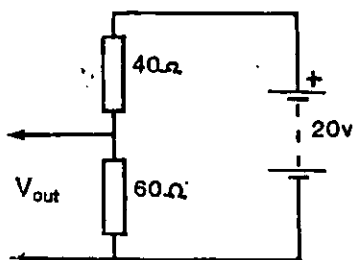
The formula for  $V_{out} = \frac{V \times R_2}{R_1 + R_2}$

Example:



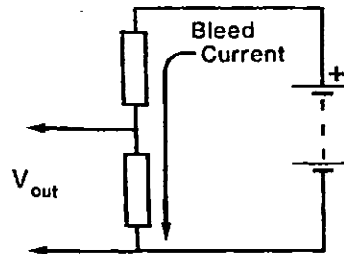
$$\begin{aligned} V_{out} &= V \times \frac{R_2}{R_1 + R_2} \\ &= 10 \times \frac{7}{7 + 3} \\ &= 10 \times \frac{7}{10} \\ &= 7 \text{ volts} \end{aligned}$$

You can see that the 10 volts supply will create one volt drop across each one ohm. By using this same reasoning, follow through this next problem:



The total resistance is 100 ohms, so that the 20 volts must be divided into 100 parts. Each ohm will see 1/5th of a volt. This means the 40 ohm resistor will have  $40 \times 1/5$  or 8 volts across it and the 60 ohm resistor will have  $60 \times 1/5$  or 12 volts across it.

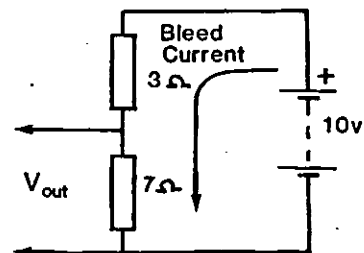
NOTE: The total of 8v + 12v must equal the supply.



NOTES: Voltage dividers draw current through the two resistors even though no components are connected to the  $V_{out}$  terminal. This bleed current flows all the time the battery is connected.

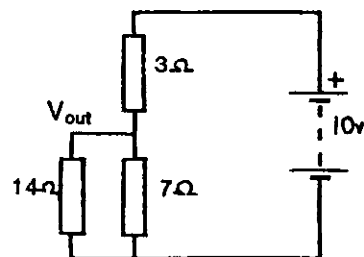
If any components are connected to the  $V_{out}$  terminal the voltage  $V_{out}$  will fall.

Voltage dividers are very wasteful with power. The "BLEED CURRENT" represents power lost.



In the example above the BLEED CURRENT is:

$$\begin{aligned} I &= \frac{V}{R} \\ &= \frac{10}{7 + 3} = \frac{10}{10} \\ &= 1 \text{ amp} \end{aligned}$$



If we wish to use the output voltage to supply a 14 ohm load,  $V_{out}$  will drop and the current will need to be calculated using these 4 steps:

1. Calculate the "equivalent resistance" of the circuit
2. Calculate the current flowing.
3. Calculate  $V_{out}$
4. Calculate the current in the 14 ohm load.

1. The resistance of the 14ohm:7ohm parallel combination

$$\begin{aligned}\frac{1}{R} &= \frac{1}{R_1} + \frac{1}{R_2} \\ &= \frac{1}{14} + \frac{1}{7} \\ &= \frac{1}{14} + \frac{2}{14} \\ &= \frac{3}{14}\end{aligned}$$

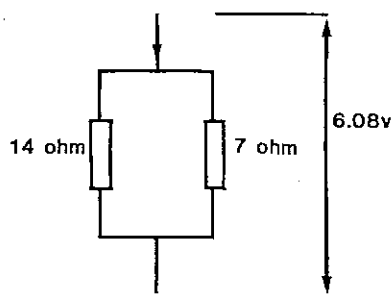
$$R = \frac{14}{3} = 4\frac{2}{3} \text{ ohms}$$

$$\begin{aligned}\text{Total resistance} &= 4\frac{2}{3} + 3 \\ &= 7\frac{2}{3} \text{ ohms}\end{aligned}$$

Current flowing:

$$\begin{aligned}I &= \frac{V}{R} \\ &= \frac{10}{7\frac{2}{3}} \\ &= 1.3 \text{ amps}\end{aligned}$$

$$\begin{aligned}3. \quad V_{out} &= V \times \frac{R_2}{R_1 + R_2} \\ &= V \times \frac{4.66}{3 + 4.66} \\ &= 10 \times \frac{4.66}{7.66} \\ &= 6.08 \text{ volts}\end{aligned}$$



4. The current in the 14 ohm load:

This is a current divider circuit and is discussed in the next section.

The 1.3 amp splits into  $I_1$  and  $I_2$

$$I_1 = \frac{6.08}{14} = .433 \text{ amp}$$

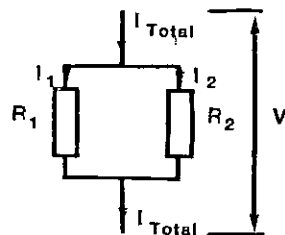
$$I_2 = \frac{6.08}{7} = .867 \text{ amp}$$

Remember the total of .433 + .867 must equal 1.3 amp.

You can see that current flow and voltage drop in a volt divider very soon becomes quite complex and the figures become involved. There is no regulation at all and this type of supply is only suitable for the most primitive of requirements.

## A CURRENT DIVIDER

To find the current in  $R_1$ , the voltage  $V$  is common to both resistors so from ohms law.



$$I_1 = \frac{V}{R_1}$$

$$\text{and } I_2 = \frac{V}{R_2}$$

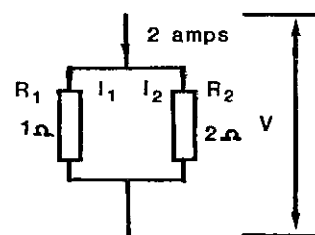
Since  $V=V$

$$I_1 R_1 = I_2 R_2$$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

thus the current divides in the inverse ratio of the resistance values.

### Problem A Current Divider



What is the current in the 1 ohm resistor?  
Write down the known quantities.

$$I_T = 2 \text{ amps}$$

Voltage across the combination =  $V$

$$R_1 = 1 \text{ ohm}$$

$$R_2 = 2 \text{ ohm}$$



From ohm's Law

$$I_1 = \frac{V}{R_1} \quad \text{---- (1)}$$

$$\& \quad I_2 = \frac{V}{R_2} \quad \text{---- (2)}$$

$$\& \quad I_1 + I_2 = 2 \text{ amps} \quad (3)$$

from (1) & (2)

$$I_1 R_1 = I_2 R_2$$

$$I_1 = 2I_2 \quad \text{---- (4)}$$

Substitute (4) in (3)

$$2I_2 + I_2 = 2$$

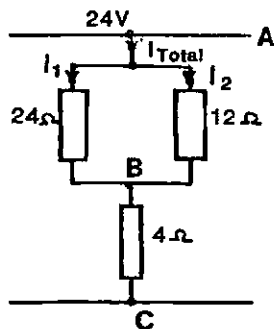
$$3I_2 = 2$$

$$I_2 = \frac{2}{3} \text{ amp}$$

$$\& \quad I_1 = 2 - \frac{2}{3} = 1\frac{1}{3} \text{ amps}$$

#### A Current Divider

When two resistors are placed in parallel, the current divides in the "inverse ratio of the resistance values". This simply means more current will flow through the 12 ohm resistor (neglecting the lower 4 ohm resistor). than the 24 ohm resistor



1. Determine the resistance of the 24 ohm/12 ohm parallel combination.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\& \quad R_T = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{24 \times 12}{36}$$

$$= 8 \text{ ohm}$$

2. Total resistance of the combination

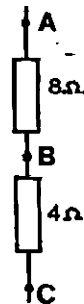
$$= 8 + 4$$

$$= 12 \text{ ohm}$$

3. Current flowing =  $\frac{24}{12} = 2 \text{ amps}$

Current in the 24 ohm resistor

The top two parallel resistors provide current splitting. The voltage across AB



$$\begin{aligned} V_{AB} &= V_T \times \frac{8}{8 + 4} \\ &= 24 \times \frac{8}{12} \\ &= 16 \text{ volts} \end{aligned}$$

So that the current in the 24 ohm resistor:

$$\begin{aligned} I &= \frac{V}{R} \\ &= \frac{16}{24} \\ &= \frac{2}{3} \text{ amp} \end{aligned}$$

#### Problems:

A 4 ohm resistor is placed in parallel with an 8 ohm resistor and this combination is in series with a 2 ohm resistor. Calculate the current in the 4 ohm resistor when the voltage across the combination is 12 volts.

What is the voltage across the above combination when the parallel resistors are 6 ohm and 18 ohm. The series resistor is 5 ohm and the current flowing in the 5 ohm resistor is 2 amps.

A 10 ohm and 30 ohm resistor are placed in parallel. In series with this is a 20 ohm resistor. If 1 amp is flowing in the 10 ohm resistor, what is the voltage across the circuit?

How many series and/or parallel combinations can be made from three resistors? And how many  $V_{outs}$  are possible with these arrangements? Take the resistor values to be 20 ohm, 30 ohm and 50 ohm with a supply voltage of 100 volts.

# DESIGNING YOUR OWN POWER SUPPLIES

-by Colin Mitchell E.E.(Hons.)

**INTRODUCTION** ALMOST ANY PROJECT CAN BE CONNECTED TO A POWER SUPPLY. THIS WILL SAVE THE COST OF BUYING BATTERIES BUT MORE IMPORTANTLY THE VOLTAGE AVAILABLE FROM A POWER SUPPLY WILL BE REGULAR & NOT "DROP OFF" AS THE BATTERY BECOMES EXHAUSTED. BATTERIES ARE IDEAL FOR PORTABILITY BUT FOR CONTINUED OPERATION A POWER SUPPLY IS THE ANSWER.

CHECK THESE FEATURES:

- DELIVERS A CONSTANT VOLTAGE
- CAPABLE OF DELIVERING HIGH CURRENTS
- " " " " VOLTAGES
- CHEAP TO RUN
- ABLE TO CHARGE RE-CHARGEABLE BATTERIES

**FIRST CONSIDERATIONS** A RANGE OF READY-MADE SUPPLIES IS AVAILABLE SO FIRSTLY DETERMINE IF THESE WILL MEET YOUR REQUIREMENTS.

IF NOT, YOU WILL NEED TO BUILD YOUR OWN UNIT. SEE IF YOUR NEEDS FALL INTO ANY OF THESE CATEGORIES:

- \* Supply required to fit into or onto an existing project.
- \* Required as a "DESIGNERS" POWER SUPPLY with numerous voltage ranges.
- \* " " " " HIGH-CURRENT POWER SUPPLY
- \* HIGH DEGREE OF SMOOTHING REQUIRED
- \* REQUIRED FOR A SPECIAL VOLTAGE

**CURRENT RANGE** POWER SUPPLIES FALL INTO 3 CATEGORIES ACCORDING TO THEIR CURRENT CAPABILITIES. YOU MUST FIRSTLY DECIDE WHICH RANGE YOU WISH TO HANDLE:

1. LOW POWER — USUALLY 150mA 250mA or 500mA.
2. MEDIUM POWER — USUALLY 1AMP TO 2AMP
3. HIGH POWER — 3AMP 6AMP 10AMP AND HIGHER

**NOTE** — THE VOLTAGE OF A POWER SUPPLY IS COMPLETELY INDEPENDENT OF CURRENT. AT ANY CURRENT RATING, THE VOLTAGE RANGE AVAILABLE IS:

1.5v → 110VOLT.

THIS MEANS WE CAN DESIGN A POWER SUPPLY FOR OUTPUTS SUCH AS:  
3v @ 10AMP or 110v @ 150mA or 32-0-32v @ 6AMP or 9v @ 1AMP

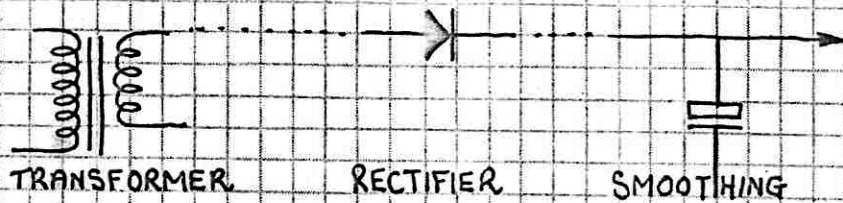
THE ONLY DIFFERENCE WILL BE THE PHYSICAL DIMENSIONS, HEAT SINKING AND COST. THESE NOTES WILL COVER THE THEORY BEHIND THEIR DESIGN.

IT WILL INVOLVE VERY LITTLE MATHEMATICS, TO KEEP THE TEXT SIMPLE.

ONCE YOU DECIDE UPON THE CURRENT YOU WISH TO DELIVER, AND THE DEGREE OF SMOOTHING REQUIRED, YOU WILL BE READY TO ABSORB THIS EASY-TO-UNDERSTAND SET OF NOTES. DO NOT START CONSTRUCTION UNTIL YOU ARE ABSOLUTELY SURE WHAT TO DO AND THE SAFETY PRECAUTIONS REQUIRED.

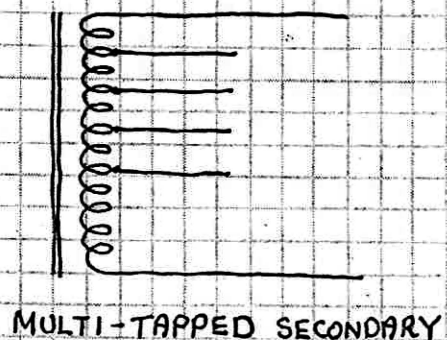
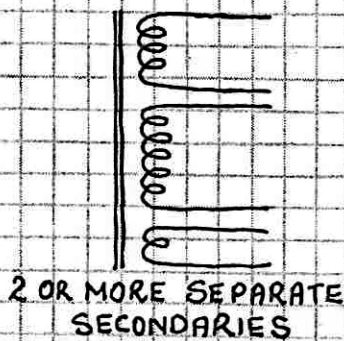
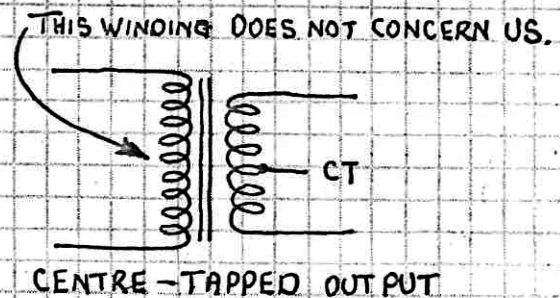
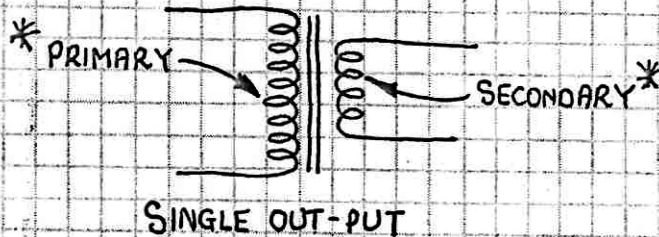


A POWER SUPPLY CONSISTS OF 3 SECTIONS



THESE NOTES WILL OUTLINE HOW THE 3 STAGES CAN BE COMBINED TO PROVIDE THE BEST AND CHEAPEST POWER SUPPLY FOR YOUR REQUIREMENTS

## THE POWER TRANSFORMER

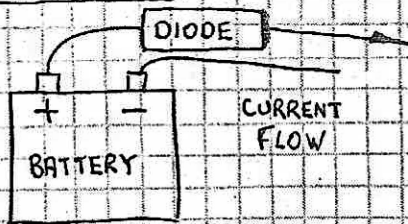


THESE ARE THE 4 MOST COMMON TYPES OF SECONDARY WINDINGS. THE PRIMARY WINDING DOES NOT CONCERN US AND IT WILL USUALLY BE LEFT OFF CIRCUIT DIAGRAM. WE ONLY DEAL WITH THE SECONDARY WINDING

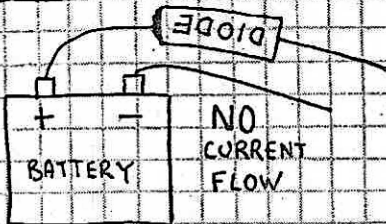
- NOTES:
- \* THE PRIMARY AND SECONDARY WINDINGS ARE USUALLY MARKED ON A TRANSFORMER. YOU MUST KNOW "WHICH IS WHICH".
  - \* THE TRANSFORMER WILL NOT WORK IF YOU CONNECT THE PRIMARY TO THE MAINS. IT WILL GET TOO HOT AND "COOK".
  - \* THE SECONDARY PRODUCES 1V AC FOR EACH 3 → 8 TURNS OF WIRE
  - \* WHERE THERE ARE 2 OR MORE WINDINGS IN THE SECONDARY, THE THICKER WIRE SUPPLIES THE HIGHER CURRENT.
  - \* A TRANSFORMER DOES NOT GIVE "DIRECT CURRENT" IT SUPPLIES ONLY "ALTERNATING CURRENT" (AC)
  - \* YOU DON'T NEED TO KNOW WHICH SECONDARY LEAD IS "IN PHASE" WITH THE MAINS
  - \* YOU CANNOT MEASURE THE RESISTANCE OF A WINDING TO DETERMINE ITS CURRENT OR VOLTAGE RATING.
  - \* THE CIRCUIT SYMBOL FOR A TRANSFORMER DOES NOT INDICATE THE SIZE OF ANY WINDING OR THE CURRENT OR WATTAGE OR VOLTAGE.

## ELECTRON FLOW

DURING EXPERIMENTATION EVERYONE MAKES MISTAKES  
ONE UNFORTUNATE MISTAKE OCCURED 100 YEARS AGO (APPROX)  
SCIENTISTS EXPERIMENTING WITH A RECTIFIER DIODE FOUND IT CONDUCTED IN ONLY ONE DIRECTION.



WHEN THEY PLACED IT IN THE POSITIVE LINE  
THEY FOUND THAT CURRENT WOULD FLOW  
WHEN IT WAS REVERSED, NO CURRENT WOULD FLOW  
THEY CONCLUDED THAT CURRENT FLOWS OUT  
THE POSITIVE TERMINAL AND THROUGH THE  
DIODE. THUS THEY GAVE THE DIODE AN ARROW  
SYMBOL SHOWING THE DIRECTION OF THE  
CURRENT FLOW:



THEY CREATED THE CONVENTION THAT ELECTRICITY  
FLOWS FROM POSITIVE TO NEGATIVE.

UNFORTUNATELY THEY WERE WRONG!

ELECTRICITY IS MADE UP OF ELECTRONS AND THESE FLOW FROM NEGATIVE TO POSITIVE. THUS ELECTRICITY DOES NOT FLOW IN THE DIRECTION OF THE ARROW.

THIS HAS CREATED 2 SCHOOLS OF REASONING. ONE CALLED 'CONVENTIONAL CURRENT' & THE OTHER 'ELECTRON FLOW'

'CONVENTIONAL CURRENT' APPLIES TO ELECTRICAL WORK AND ELECTRICIANS

### ELECTRICAL WORK:



'CONVENTIONAL CURRENT FLOW'

FOR LAMPS, SWITCHES MOTORS ETC.

### ELECTRONIC WORK:



'ELECTRON FLOW'

FOR DIODES, TRANSISTORS ETC

WE USE ELECTRON FLOW IN OUR:

## **3 BASIC POWER SUPPLY CIRCUITS**



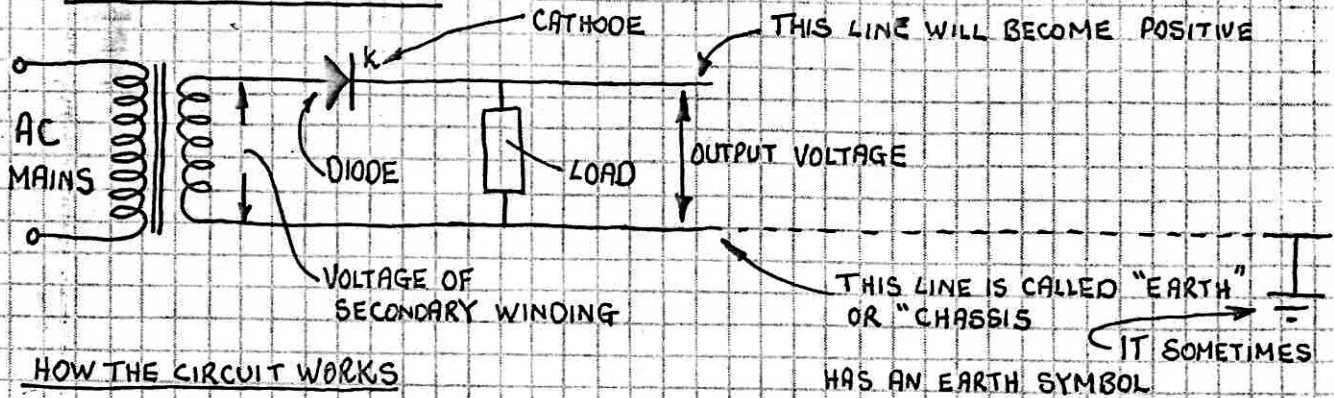
COMBINATIONS OF THESE WILL GIVE 3 DIFFERENT CIRCUITS.



# THE 3 POWER SUPPLY CIRCUITS ARE:

1. HALF-WAVE ..... WITH 1 DIODE
2. FULL-WAVE WITH CENTRE-TAP TRANSFORMER ..... WITH 2 DIODES
3. FULL-WAVE BRIDGE RECTIFIER ..... WITH 4 DIODES

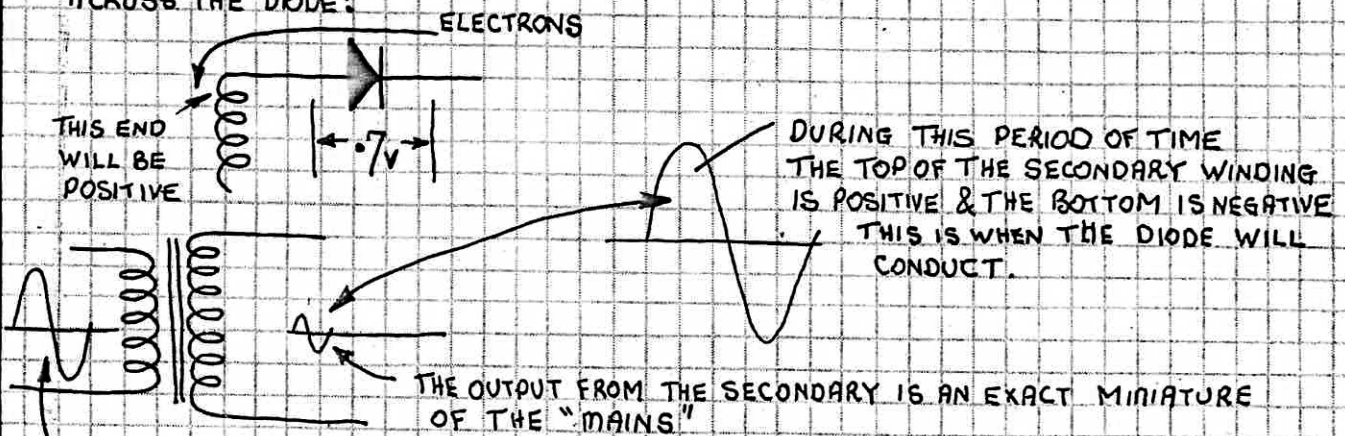
## 1. HALF WAVE RECTIFIER



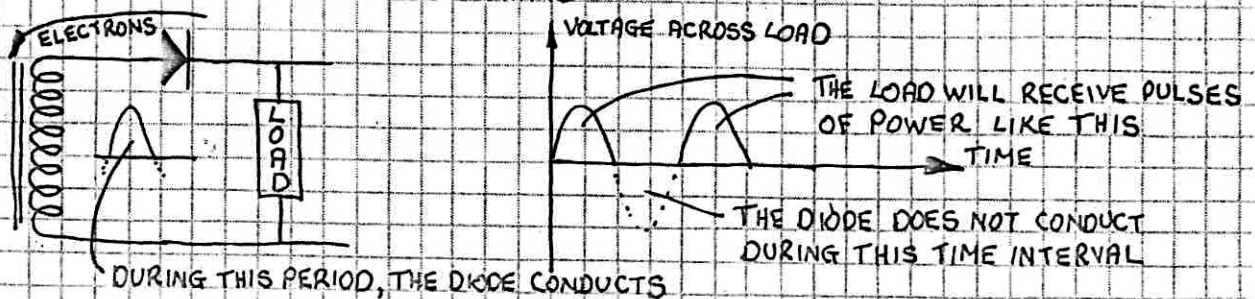
### HOW THE CIRCUIT WORKS

WHEN THIS END OF THE DIODE IS RAISED  $0.7V$  HIGHER THAN THE OTHER END, IT BEGINS TO CONDUCT ELECTRONS IN THIS DIRECTION

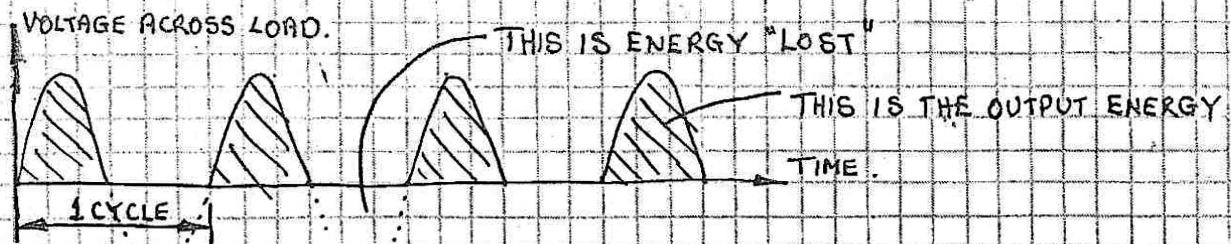
DURING CONDUCTION THERE WILL BE A VOLTAGE OF  $0.7V$  ACROSS THE DIODE:



THE INPUT WAVEFORM FROM THE "MAINS"



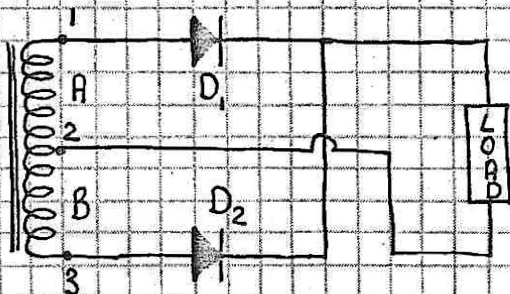
THE ENERGY FROM A HALF-WAVE RECTIFIER LOOKS LIKE THIS:



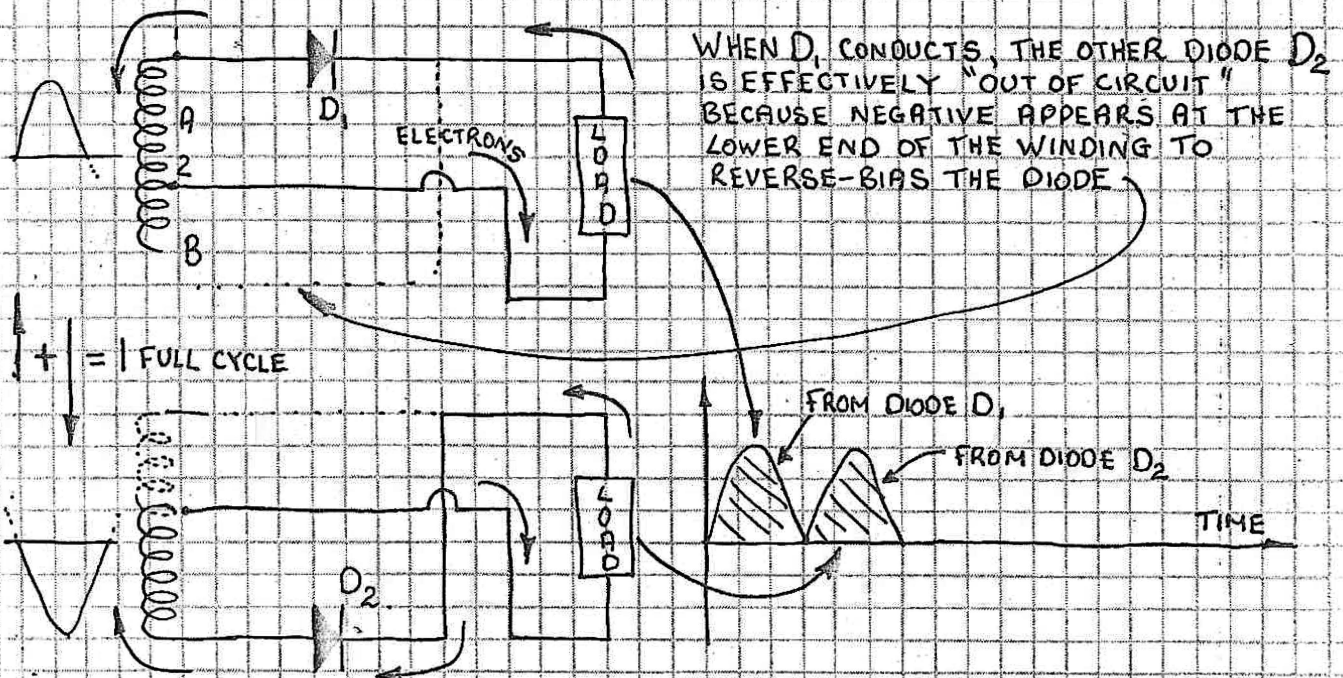
ONLY ENERGY FROM THE FIRST HALF OF EVERY CYCLE IS OBTAINED.

TO OBTAIN ENERGY FROM THE FULL CYCLE, WE NEED TO LOOK AT:

## 2. FULL-WAVE RECTIFICATION



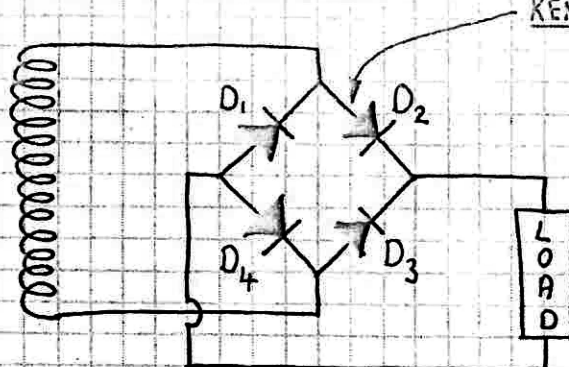
A CENTRE-TAPPED TRANSFORMER AND 2 DIODES FORM A FULL-WAVE CIRCUIT. IT OPERATES AS 2 SEPARATE  $\frac{1}{2}$  WAVE CIRCUITS. WHEN THE TOP DIODE CONDUCTS, THE LOWER DIODE IS NON-CONDUCTING AND VICE VERSA.



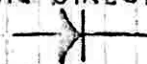
THE TWO DIAGRAMS REPRESENT 1 FULL CYCLE. NOTICE THE ELECTRONS FLOW THROUGH THE LOAD IN THE SAME DIRECTION FROM EACH HALF CYCLE. A FULL WAVE CIRCUIT DELIVERS 2 PULSES OF ENERGY DURING EACH CYCLE.



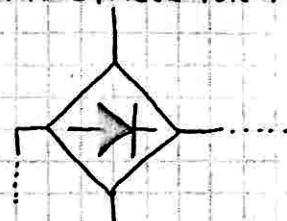
## 5 FULL WAVE BRIDGE RECTIFIER



REMEMBER: ALL THE DIODES FACE IN THE GENERAL DIRECTION OF:

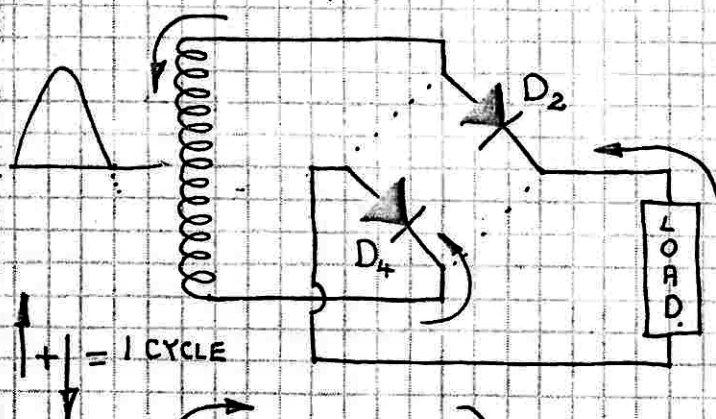


FOR THIS REASON WE SOMETIMES SEE THE SYMBOL FOR A BRIDGE AS:



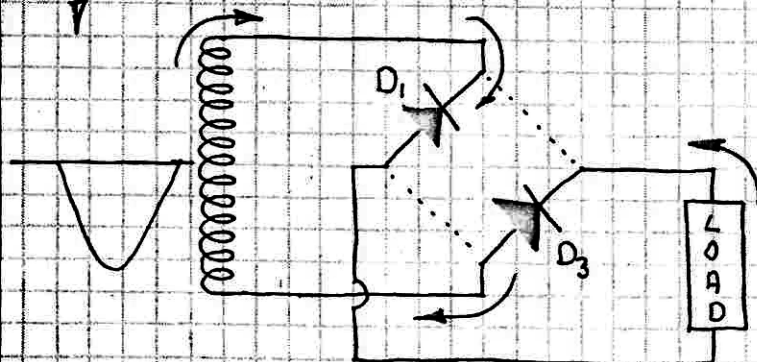
A FULL WAVE CIRCUIT CAN BE MADE BY USING A SINGLE SECONDARY WINDING AND 4 DIODES. THESE ARE ARRANGED IN A BRIDGE AS SHOWN.

THE OPERATION OF THE CIRCUIT IS BEST SHOWN IN 2 DIAGRAMS:

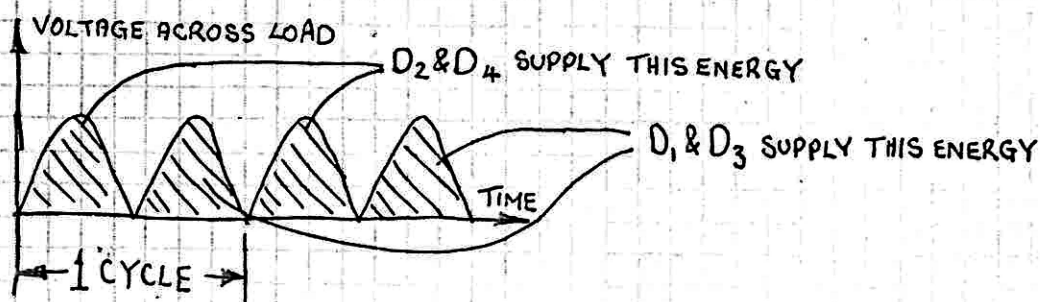


WHEN THE TOP OF THE WINDING IS POSITIVE, DIODES  $D_2$  &  $D_4$  ARE FORWARD BIASED AND SUPPLY THE LOAD WITH ENERGY.

DIODES  $D_1$  &  $D_3$  ARE REVERSE BIASED AND ARE EFFECTIVELY "OUT OF CIRCUIT".



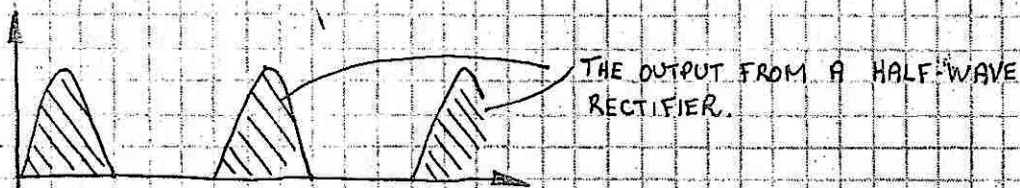
NOTICE: EVEN THOUGH THE POLARITY IS CHANGING FROM THE SECONDARY WINDING, THE ENERGY IS PASSING THROUGH THE LOAD IN ONLY ONE DIRECTION.



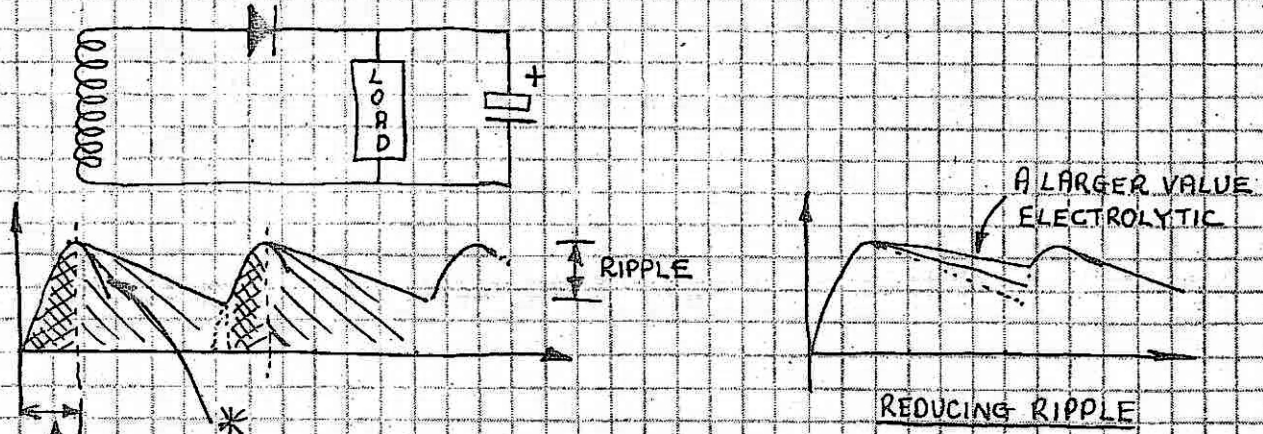
ALL THE RECTIFIER CIRCUITS 1, 2 & 3 PRODUCE PULSATING DC AND IT MUST BE SMOOTHED BEFORE IT IS SUITABLE FOR ANY ELECTRONIC CIRCUITS.

## FILTERS

A FILTER SMOOTHS PULSATING DC FROM EITHER A HALF-WAVE RECTIFIER OR A FULL-WAVE RECTIFIER. IT IS BASICALLY A HIGH-VALUE ELECTROLYTIC WHICH IS CAPABLE OF STORING ENERGY DURING PART OF THE CYCLE THEN DELIVERING IT DURING THE "LOWS".

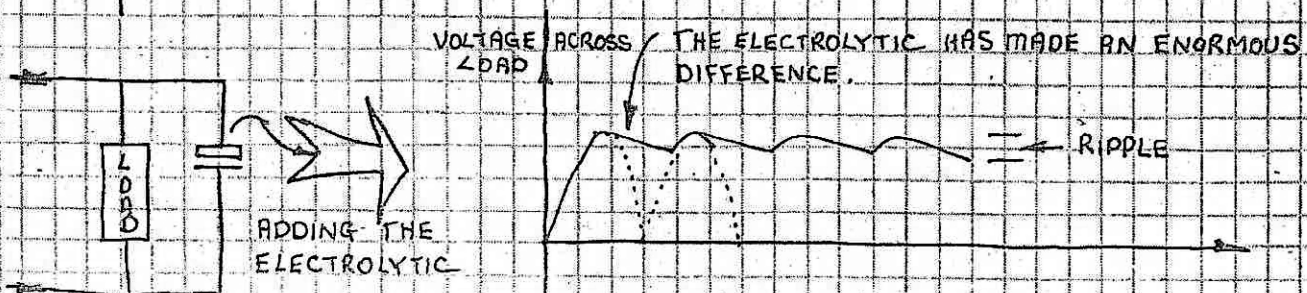
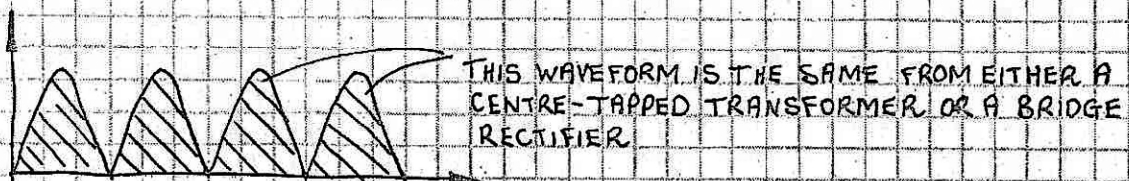


IF WE ADD AN ELECTROLYTIC TO THE HALF-WAVE RECTIFIER CIRCUIT:



THE TRANSFORMER & DIODE SUPPLY A VERY HEAVY CURRENT FOR THIS PERIOD OF TIME AS THEY ARE SUPPLYING THE LOAD & CHARGING THE ELECTROLYTIC. ONCE THE VOLTAGE RISES TO A PEAK IT WOULD NORMALLY FOLLOW THE CURVE MARKED \* BUT THE ELECTROLYTIC HAS A SLIGHTLY HIGHER VOLTAGE AND TAKES OVER COMPLETELY BY DELIVERING ITS ENERGY TO THE LOAD. THE VOLTAGE DOES NOT FALL TO ZERO BEFORE THE NEXT PULSE ARRIVES. THE DIFFERENCE BETWEEN THE "PEAKS" & THE "LOWS" IS CALLED RIPPLE. OUR AIM IS TO REDUCE THE RIPPLE TO ZERO. THE HALF-WAVE CIRCUIT RELIES HEAVILY ON THE ELECTROLYTIC TO PROVIDE SMOOTHING. THIS IS DUE TO THE LARGE GAP BETWEEN EACH PULSE.

## SMOOTHING A FULL-WAVE CIRCUIT



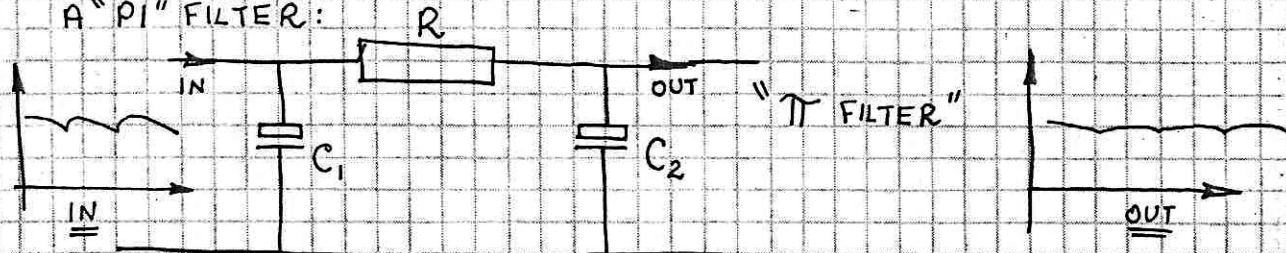


WE HAVE SEEN HOW AN ELECTROLYTIC WILL REDUCE THE RIPPLE TO A LOW LEVEL HOWEVER THIS SIMPLE FORM OF REGULATION IS NOT NEARLY GOOD ENOUGH FOR ELECTRONIC EQUIPMENT. WITH RIPPLE VALUES AS LOW AS 1V WE WILL BE ABLE TO HEAR AN ANNOYING HUM IN THE BACKGROUND OF AMPLIFIERS OR SEE A DISTORTED PICTURE GRADUALLY MOVE DOWN THE SCREEN ON VIDEO MONITORS AND IN COMPUTERS, EVEN THIS LOW LEVEL RIPPLE WILL GIVE INCORRECT OPERATION. SO WE MUST REDUCE THE RIPPLE EVEN FURTHER. HERE ARE 3 SUITABLE FILTERS:

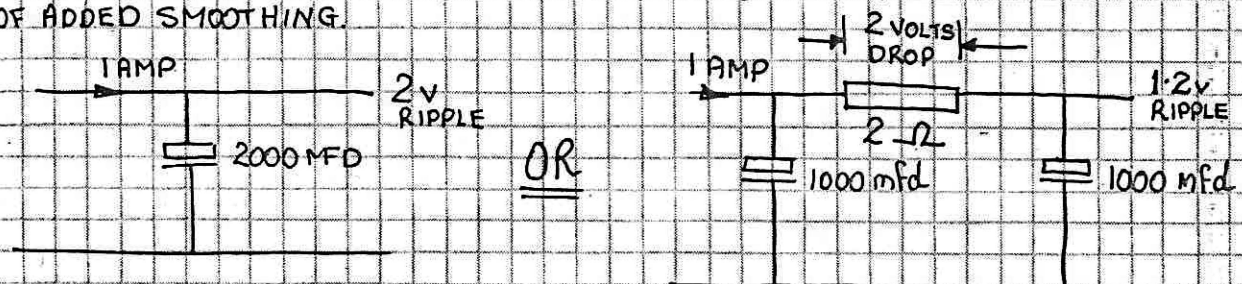
1. RC FILTER
2. LC FILTER
3. ELECTRONIC FILTER

### 1. RESISTANCE - CAPITANCE FILTER

THIS IS THE CHEAPEST FORM OF SMOOTHING. IT USUALLY TAKES THE FORM OF A "PI" FILTER:



THE MAIN DISADVANTAGE WITH THIS FILTER LIES IN THE HIGH LOSS FROM THE RESISTOR. WE RELY ON A VOLTAGE DROP ACROSS THE RESISTOR TO SEPARATE THE VOLTAGES ON THE ELECTROLYTICS AND THUS GET SOME DEGREE OF ADDED SMOOTHING.



COMPARE THE 2 CIRCUITS ABOVE. IN THE FIRST WE HAVE ONE ELECTROLYTIC OF 2000 MFD FOR SMOOTHING. IN THE SECOND CIRCUIT WE HAVE SPLIT THE ELECTROLYTIC INTO 2 PARTS AND INCLUDED A 2 OHM RESISTOR TO FORM A "PI FILTER". AT A CURRENT OF 1 AMP THE FIRST CIRCUIT WILL HAVE A RIPPLE OF ABOUT 2 VOLT WHILE THE SECOND CIRCUIT WILL HAVE A RIPPLE OF 1.2V. BY ACHIEVING A LOWER VALUE OF RIPPLE WE HAVE LOST 2 VOLTS ACROSS THE RESISTOR. THIS INDICATES AN RC FILTER IS NOT VERY EFFECTIVE FOR HIGH CURRENT SITUATIONS.

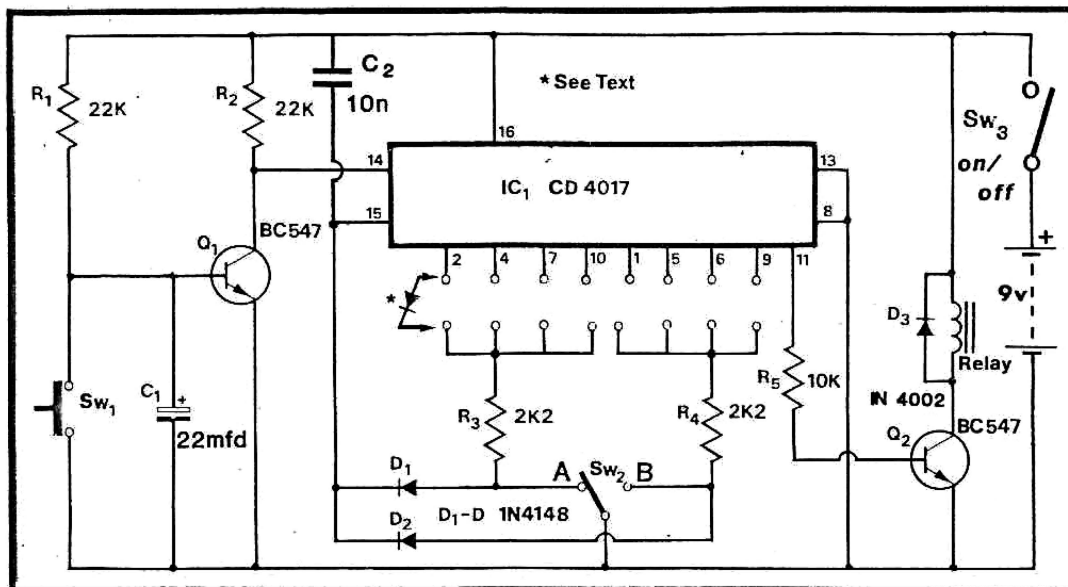
### SIZE OF ELECTROLYTIC

THE SIZE OF THE ELECTROLYTIC IS DETERMINED BY THE CURRENT DEMAND OF THE POWER SUPPLY. THE NORMAL RULE IS 2,000 MFD/OUTPUT AMPERE, HOWEVER IT SHOULD NOT BE LESS THAN 1,000 MFD. GOOD SMOOTHING AT THE DIDDIES MAKES IT EASIER FOR THE NEXT STAGES OF FILTERING.

# COMBINATION LOCK

by Tony Lines N.T

Yet another combination lock puzzle. This time it's alterable!

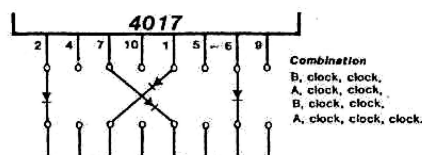


This project is an extension of LIGHT THE LED. It uses the same principle for clocking the decade counter, CD 4017 and in place of the LED we have a transistor and relay. But the main difference between the two circuits lies in the combination setting. LIGHT THE LED has a single combination which can not be easily altered. This circuit has moveable gating diodes which can easily be moved to pre-set a combination then be withdrawn from the Molex pins to set another combination. On the circuit we have shown only one gating diode however there is an allowance of up to 4 gating diodes. It is not possible to use more than 4 diodes as will be explained later. These diodes can be directed to either the left hand or right hand 2k2 resistors making the total number of possibilities quite large. Possibly the only problem with any combination lock is remembering the sequence once you have set a programme. It may be possible to remember it for one day, but memorizing the arrangement over a long period of time will need a memory code. Something along the lines of "U" for up and "D" for down could be written on or near the press-buttons, with the letters written backwards . . . anything to confuse prying fingers.

The first output of the decade counter is pin 3. It has not been shown on the circuit diagram since it will be sitting HIGH during standing or when first switched on and will not affect the circuit operation. Any clocking of Sw<sub>1</sub> will advance the HIGH to pins 2,4,7, etc and become capable of resetting the counter. You may choose any number of diodes up to 4 and fill the row of Molex pins in any sequence you desire. With the addition of the on/off switch, the chance of cracking the combination is pretty remote and you can be assured of safe, reliable operation. The advantage of being able to change the combination should be obvious. Suppose you are remote from the scene and

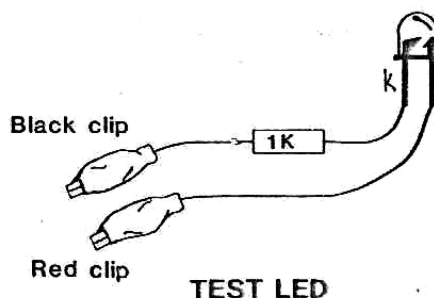
wish to instruct someone else to open the lock. You will be able to relay the sequence over the phone, then change the combination to make the lock secure again.

A typical combination with 4 diodes would be set like this:



All diodes must have their cathodes as shown

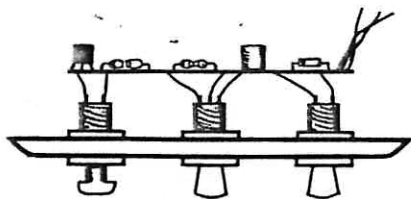
We have included 3 possible combinations and their "retrieval code". When making your own combinations remember to take each diode to an alternate 2k2 resistor to decrease the chance of solving the puzzle. You must also use only every alternate output of the CD 4017 so that you have sufficient time to alter the change-over switch ready for the next clock pulse.





## MOUNTING THE SWITCHES

Mounting the switches will be up to your own individual choice and you can decide upon hiding them or openly exposing them. Quite often, if they are openly displayed, they are by-passed by the prowler as being non-important. As the old saying goes; if you want to hide a \$50 note, place it in an obvious position. Nothing could be more obvious than a switch-plate with a couple of switches. (Actually 3 switches). These switches are designed for switching household lights and there is nothing preventing us from using them for this situation. They provide the perfect decoy. Most of the switch inserts are designed for two-way operation and one of them can be used for the change-over switch  $Sw_2$ . The PC board is kept in position behind the plate with lengths of stiff copper wire as shown. The first switch is the clocking switch  $Sw_1$ , the middle switch is the gating switch  $Sw_2$ , and the third switch is the on/off switch  $Sw_3$ . Every time the on/off switch is activated, the CD 4017 is reset via the 10n capacitor connected to the reset pin 15. This will make it virtually impossible for anybody to crack the combination as this switch will be activated some time during their attempt, setting them off to zero again. With the addition of this on/off switch, the life of the battery will be almost its full shelf life.



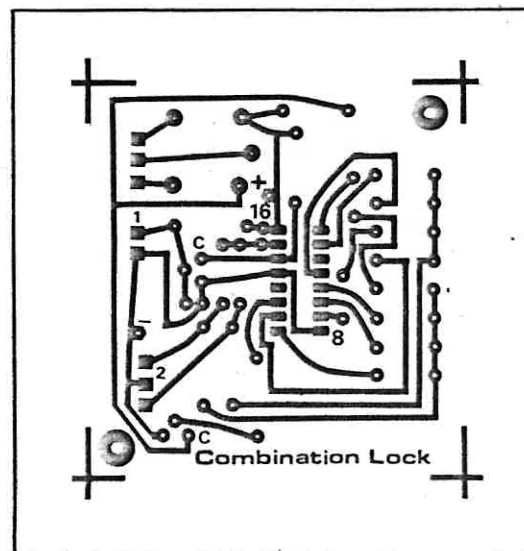
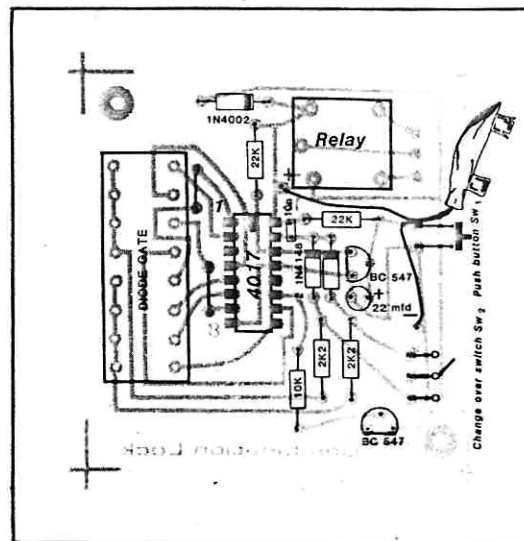
The 3 switches mounted on a plate

A pre-drilled printed circuit board is available for this project and will make construction a lot easier. Firstly fit the relay and Molex pins to the board then the resistors and capacitors, diodes and finally the integrated circuit. The IC can be mounted on a socket if you wish. It will make testing a lot easier. Connect leads from the board to the switches with wire which is stiff enough to support the board and allow it to sit behind the switch-plate. A small 9v battery will be sufficient to power the project as it will be turned off most of the time and will only require power during its short operating periods.

The output from the relay is intended to operate a solenoid. Solenoid actuators are available from some of the larger hobby shops and they provide a push-pull motion when power is applied. They are a fairly inefficient use of energy as they require a fairly high current for even the feeblest output force. It is much more effective to use a small three-pole motor and gear-box. This will need a limit switch on the output so that it will be capable of inserting or withdrawing a bolt from the lock.

We are now breaking into a completely different field, that of ELECTROMECHANICS. We could devote a whole project to describing the mechanics of the actuating mechanism but one simple way out is to dismantle a battery operated toy and use the motor and gear-box for this project. A limit switch will be required on the output shaft and can be made from springy brass. One contact will have to be insulated from any metal-work as this will go to one lead of the

battery. The output of the relay connects across the limit switch so that the limit switch takes over from the initial closing of the relay. This means that when you hear the motor start-up, you must switch off the combination lock circuit so that the motor will stop after exactly half a turn of the output shaft. The output shaft will need to be cranked so that it will be capable of moving a slider or bolt back and forth. It will give a forward motion during one half cycle and remove the bolt during the other half revolution. I used this simple idea a number of years ago on our back door and it obviated the need for one of those old-style laundry-door keys.



## TESTING

The project is tested BEFORE any gating diodes are inserted. Insert the battery and press the clock switch 9 times. The relay should energise. If the relay does not operate, you will need to follow through a number of steps. Here they are:  
Firstly make up a test LED by connecting an LED to a 470 ohm resistor and fitting two leads connected to a red and a black alligator clip. This will be an invaluable piece of test equipment, even though it looks so simple.

### PARTS LIST

R1	resistor	22k	$\frac{1}{4}$ watt
R2	"	22k	"
R3	"	2k2	"
R4	"	2k2	"
R5	"	10k	"

C1	electrolytic	22 mfd	16v
C2	capacitor	10n	100v

D1	diode	1N 4148
D2	"	1N 4148
D3	"	1N 4002
D4	"	1N 4148
D5	"	1N 4148
D6	"	1N 4148
D7	"	1N 4148

Relay 6v coil with c/o contacts

Q1, Q2 transistor BC 547

IC1 Counter CD 4017

Sw1 push to make switch

Sw2 change-over switch

Sw<sub>3</sub> on/off switch

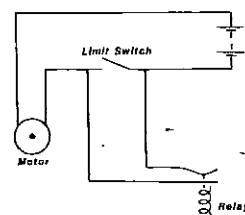
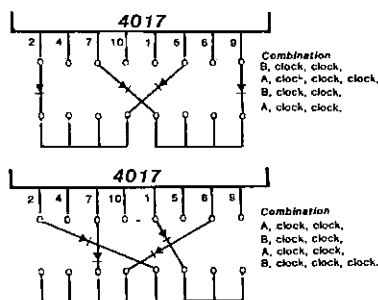
Battery snap

9v battery

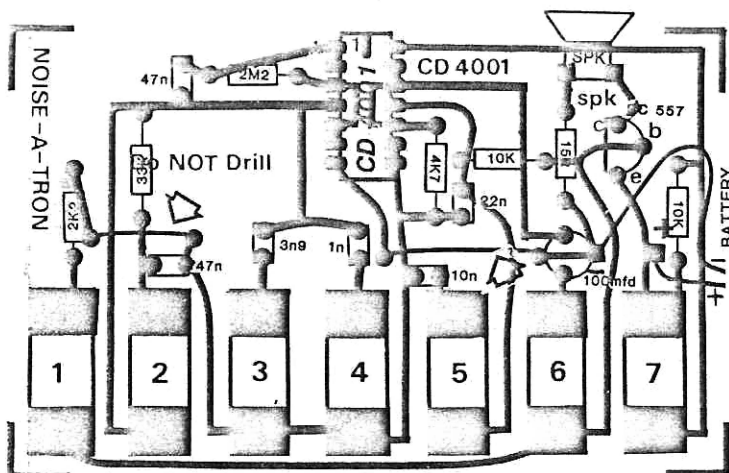
COMBINATION LOCK PC BOARD

Begin by re-setting the CD 4017 IC and check pin 3 for a HIGH. This is done by clipping the red alligator clip to pin 3 and the black lead to earth, or negative rail. If pin 3 is not HIGH, check all the outputs one at a time to determine which output is HIGH. Reset the CD 4017 via a 10k resistor from the positive rail to pin 15. Pin 3 should now be HIGH. If not check that pin 8 and 13 are grounded and that the input clock pin 14 is not receiving spikes from some unknown source. Pin 14 can be decked for this test. The first requirement is to get a HIGH on pin 3. Once this is achieved, clock the IC one cycle and test pin 2 with the test LED. If pin 2 is not HIGH, go through the outputs in the order 3,2,4,7,10,1,5,6,9,11, and locate the output which has gone HIGH. This will reveal if the IC is receiving one clock pulse or more than one clock pulse for each push of the button. If the counter advances two or three outputs, the clocking circuit will need to be checked for de-bounce. Some IC's are very prone to noise and will not be suitable for this simple de-bounce network. The 22mfd electrolytic is responsible for controlling and eliminating much of the switch noise and this is further reduced by the action of the transistor. It may be necessary to add an electrolytic across the battery or

even a small capacitor across the supply line. duce line pulses. When you are satisfied that it is clocking one output per clock pulse, reset the and supply it with 9 pulses. The relay should activate. Next insert a diode as shown in the circuit diagram and close switch Sw<sub>2</sub> so that line A is decked. Run through the counting sequence to confirm that the switch is firstly decking the pulses, then passing the pulses when the switch is changed over. Remove the diode and confirm similar operation on line B. Once all these points are confirmed, they can be brought together by inserting one diode on the left hand output and one on the right hand output. Work out the sequence needed to avoid resetting the chip and try your first sequence. The relay should operate after 9 clock pulses.



OOPS...



Note the two jumpers arrowed

Five small discrepancies crept into the NOISE-A-TRON in the last issue. And dozens of readers wrote in to ask for the corrections. We have re-drawn the layout diagram to make the parts location easier to follow. We must point

out that the choice of components in this circuit will take wide tolerances. The idea of the circuit is to select from a ranges of values to make the various noises. In fact, you can use a BC 547 in place of the BC 557 provided it is wired correctly. See also our readers contribution of a Noise-A-Tron on the letters page.

#### PARTS LIST

R1	10k	C1	47n
R2	2M2	C2	1n
R3	33k	C3	3n9
R4	220k	C4	47n
R5	10k	C5	22n
R6	2k2	C6	100mfd
R7	15R	C7	10n
2 1/4" speaker		Q1	BC 557
battery clip		IC1	CD 4001
9v battery			
NOISE-A-TRON PC Board			

# SHOP TALK

Another 8 weeks has flown by and I can honestly say we are gaining ground with the publication. We are getting a lot more enquiries from experimenters asking about circuit design improvements and substitutions for the projects we are describing. Although all the projects are constructed by two or three different people, we do not make a point of specifying substitute values. In general, most of the circuits are so non-critical that almost any passive components would suffice so long as they are only one value either side of that specified. It's only when you get integrated circuits that the exact same device must be used. Sometimes TTL can be substituted for CMOS but only after the supply voltage has been changed, and the biasing arrangements looked into. At this stage I would not like to see anyone become involved with major circuit re-design and so try to specify only CMOS devices when ordering. The only disadvantage with CMOS is the possibility of damage during handling due to static electricity. Once they are in circuit, their advantages far outweigh the older Transistor Transistor Logic series.....especially for operation off batteries.

The most interesting portion of the mail has been the incredible interest in the project book we mentioned in issue 4. These booklets are designed around a central theme and contain a Printed Circuit Board on which the main project is constructed. We have been literally swamped with requests for the first issue. This has led us to re-consider the print run and we have decided to increase the quantity to enable all the requests to be fulfilled. This will mean we will produce a few extra copies for those who forgot to send in last month. If you are quick off the mark this time you will be included in the mailing list. The main limitation to the production quantities is the printed circuit board. This accounts for the major portion of the cost since they are top quality, roll-tinned fibre-glass boards. Needless to say, the production of additional ideas like this is sorely needed and your encouraging response has given us impetus to extend into further issues. The first issue describes a MINI FREQUENCY COUNTER. The book and board costs \$3.95 and shows you how to construct a frequency counter for about \$25.00. Further issues are in the planning stage. The five-issue series is discounted to \$19.50 and so far has proven to be the most popular choice. The printing of the first issue will be in a few weeks after you receive this issue so don't despair! It's a very large undertaking.

## WHAT ABOUT THE FREE ISSUE OF TE?

As an inducement to buy TE, we had 20,000 extra copies of issue number 1 for insertion into issue number 3. But since we printed 35,000 copies of issue 3, some of our readers had to miss out. It was not possible for us to interleave the thicker issues with the normal issues. This meant that some states had to miss out completely on the promotion. The idea of the free issue was for you to pass it on to a friend. We thought you would not have any use for two copies of the same issue. But we were wrong. Most of you are hoarders! You have kept the free issue and not passed it on as intended! Our penetration depends on you.

Tell your friend about TE and keep enquiring at your local electronics shop for kits and PC boards. For who have already done this...thanks. The word is getting around slowly.

This brings me to two stories

The first comes from an acquaintance in the printing and electronics industry. He expressed some considerable dislike in the format of the magazine, saying the third issue was "unreadable and ugly". I don't know what basis he used for his comparison..... maybe a glossy architects magazine or an overseas Woman's Journal. Realistically speaking, he should have used a club magazine, duplicated on a hand-cranked machine, for comparison. Without any qualifying points for his claims, I did not take them very seriously and let the criticism pass. A few weeks later I heard through the grapevine that his 14 year old son thought the same issue was the best to date! So if we get this diversity within the one household, what hope have we of pleasing everyone? We can't! ... and I think it would be an impossibility to try to do so.

We aim to instruct. This should be obvious by now as we include many hand-written pages in the magazine. Nothing could be simpler than a hand-written page. But do you realize that you learn 5 times more facts from hand written notes, than printed notes. It has a lot to do with the novelty and partially the photographic retention of you mind but mostly it is to do with the association with black-board writing. From the feed-back we are sure it is the most successful method of presenting the digital course. About one in four letters specifically mention how much they have learnt from it. So we must be doing something right!

Our other story highlights another extreme. Remember the number of letters we received from readers criticizing the requirement to cut out coupons from the magazine when there is an informative article on the reverse side. Here is our answer:

About a fortnight ago, we had a visit from one of our regular customers who drives 100 kilometers just to buy our latest printed circuit boards. Under his arm he had a neat stack of manilla folders. He didn't need any persuasion to show us what he had been doing. In each folder he had a separate article from Talking Electronics. He said he bought three copies of each issue. One he kept intact. The other two he cut up for the articles. What organization! Now I know why the newsagent in his town sold out of their allotment of three issues!

## CORRECTIONS TO ISSUE 4

The MJE 2955 does not have the same leadouts as the TIP 2955. This is the correct pin-outs:

P 19. Basic Electricity.  
Example 6.

$$\begin{aligned} \text{Power} &= V \times I \\ &= 3 \times 2 \text{ watts} \\ &= 6 \text{ watts} \end{aligned}$$

P 28 Noise-A-Tron  $R_2$  should be 2M2

P 66 The caption beside the Advertising Sign should read: The square solder land indicates the anode connections.





# LETTERS...

Dear Sir,

Congratulations on a superb magazine. I am really pleased to see that somebody is talking about digital electronics, as this is what the 80's is all about. I am currently doing year 10 at Technical College and as yet not one teacher is teaching us about digital electronics, so this new magazine is a real help to me, being a newcomer. The 10 MINUTE DIGITAL COURSE is an excellent idea and the hand-written notes make it easy to follow. I have enclosed an article and circuit for an AM transmitter having about the same range as the FM transmitter described in issue 4. I have built both units and they operate very successfully.

F. Capagna, 3171.

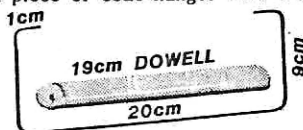
Thanks for your project. We will include it in a forthcoming issue. Maybe if you showed the magazine to your instructors, you may start something in the digital field. I know the problem. It's not the lack of digital information, it's the lack of easy-to-understand information. That's the very reason for the introduction of the magazine. We have already had an incredible response from schools all over Australia for copies, copying rights and kits of parts. Many schools are still un-aware of the magazines existence and if you are really interested in the subject of digital electronics, you can ask your teacher to send for a free copy.

Dear Sir,

I am just a hobbyist. The hours I've wasted in search of a 10 ohm resistor, or whatever, from a box of 350 various values is beyond recall. Sure, let's sort them into their values and store them into jars or boxes but think of the room taken up by 70 odd boxes or jars.

Now the purpose of my letter is to show how I solved this annoyance. I obtained a number of plastic bags (very similar in size and shape to the coin bags supplied by the trading banks) and this is what I did:

1. Sort R's into values and place into bags.
2. Bought some stick-on labels (2cm x 2cm @ 75c per 500) from our local newsagent.
3. Printed the value on the label and stuck it onto the top right-hand side of the bag.
4. Bent a piece of coat-hanger wire into this shape



5. Cut a piece of 3/4" dowell approx 19 cm long and drilled a hole into each end to take the wire.

6. Threaded the bags onto the wire in correct numerical order and fitted the wire into the dowelling.

Hey Presto! One "El cheapo" resistor store. Total time about 3 hours. Time to find a particular resistor: 3 seconds.

Try this idea yourself, see if you can spill the resistors when you hold the dowelling handle. Beauty, isn't it? "Back Murphy - Back".

J.M. Burnell, 3121.

Thanks for this handy idea. The only point which concerns me is - where are you going to get 100 or so money bags? I realize they want to be fairly strong and need the closing seal along the top for strength as well as sealability. But I don't know where they available other than a jewellers supply store. This is where we obtain our thousands of bags for assembling the

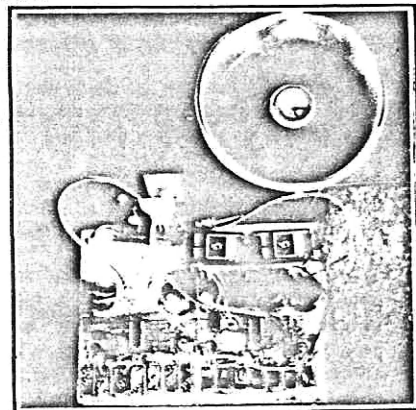
kits. The minimum number of any one size is 1,000 and this would be too many for the average hobbyist. I will leave it to you - your an enterprising lot.

Dear Sir,

I recently purchased 2 Noise-A-Tron kits with PC boards and upon building the first kit, found it had only minimal volume. I then hooked it up to a 4 transistor push-pull amplifier, which built up the volume a bit, but still not enough. Then I decided to experiment on the second and substituted 120n caps for the 47n, 22n for the 2n2, 15n for the 10n and also substituted a BC 558 transistor for the BC 547. Then I installed variable resistors in place of some of the fixed ones. This resulted in earsplitting tones from the horn speaker. I was so pleased with the result that I shot inside for a Polaroid camera. I have enclosed a quick shot of my achievements. Fitting the variable resistors has negated the need for most of the keyboard and as you can see, I did not have any brass strip so I had to resort to the next nearest thing: a beer can. Now, out of all the kits I have built, the kids and I enjoy this one the most. Now they want me to fit it to the car and go down the street sounding like the "Empire Starship".

L. Turner 3518.

(Editors note: Don't place too much strength on altering the value of the components to increase volume. Most of the gain in the writers project came from the power amplifier added to the output of the Noise-A-Tron. In fact changing the transistor from an NPN to a PNP will make virtually NO difference to the output of the Noise-A-Tron itself. Most of these changes would merely alter the frequency of the oscillators and not their output amplitude. Even so, don't think I am decrying the writers efforts. This is exactly what I want to receive. It shows the enormous potential for each and every project we describe. More ideas like this will help other readers and constructors.)



Just in case you want to duplicate my circuit, I have enclosed a list of components I have used.

- R1 - Variable pot - 10k
- R2 - " " - 2M
- R3 - " " - 30k
- R4 - " " - 250k
- R5 - " " - 10k
- R6 - " " - 2k
- R7 - " " - 15R

- C1 - .12mfd
- C2 - 1n
- C3 - 3n9
- C4 - .12mfd
- C5 - .022mfd
- C7 - .015mfd
- C6 - 100mfd 10v

- Q1 - BC 557
- IC1 - CD 4001

Power supply 6 - 9v

## NZ PARTS PROBLEMS

I am most impressed with your new magazine and its appropriate level for junior electronics hobbyists. Electronics Clubs in school have been waiting for something like this for years, as the levels in other magazines tends to get more advanced.

One problem exists for us over here in New Zealand, however, is that quite often PC's and chips in overseas magazines are not always readily available for public purchase, or if indented become expensive.

I would suggest that you consider running some NZ advertisements and information pages and possibly engage an Auckland firm such as, Orbit Electronics (Kitset Shop) 161 Hobson Street or John Gilbert (Wholesale and retail shop) Tasman Building, Anzac Avenue, to collate New Zealand mail orders and get components over from Australia in bulk in conjunction with each issue of Talking Electronics. Perhaps such a firm could keep orders open until the end of the current magazine month and then import and post components the following month. This of course would introduce delay but create a convenient line of supply.

Finally I could see many schools that have hardly ventured into electronics, such as ours, being interested in hearing about your magazine. I wish you well with your magazine.

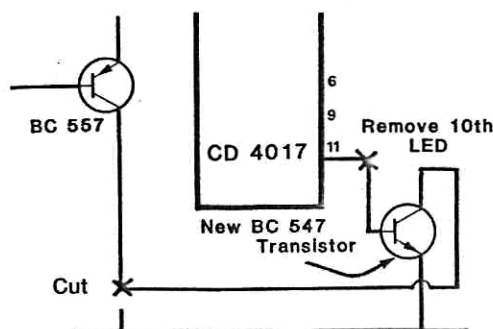
R E Francis  
H O D Science

## EXPERIMENTER DECK MOD

I really enjoy your magazine and have found it very interesting and informative. The hee haw siren was actually the first project I have built that works. The rest of the family enjoy the cricket game and have told me it is the only useful thing I have made. I have incorporated two small modifications with the experimenter deck.

First I removed the final LED and soldered the base lead of a BC 547 transistor into the anode hole on the board. Next I removed the collector lead of the BC 557 and soldered it to the collector lead of the BC 547. I then soldered the emitter lead of the 547 into the space formerly occupied by the collector lead of the 557. The process is a simple method of adding sound effects to the cricket game. Instead of lighting the tenth LED when a player is bowled, the modified circuit sounds the siren. The second modification was "suggested" by my Mother. It was simply the addition of a 500 ohm switched pot to act as a volume control. I placed this in series with one speaker lead. The enclosed circuit shows how the extra transistor is wired into circuit to provide this additional function.

G. McLean  
Gore, NZ



## EXPERIMENTER DECK DRIVES COW

I really must protest. I first became interested in your magazine when I discovered a copy of Issue No. 2 in my local bookshop.

Realizing that I required Issue No. 1 to find out more about the projects I started the big hunt. After many calls to bookshops in my own town and Auckland, I finally discovered a copy just three days before Issue No. 3 arrived.

What do I find? You guessed it, a nice copy of Issue No. 1 included. Needless to say a regular order has now been placed.

Now that I have all copies, the projects are all coming along nicely, and for a relative newcomer to electronics I feel that I have learnt a lot in a very short time.

In fact I have already "jumped the gun" and included the musical section of the experimenter deck and sound effects from "Blakes Reach" to Scottish Bagpipes are easily obtainable.

I understand that one of your readers could not get the LED ZEPPELIN to work and yet mine has worked satisfactorily from start and leads to many frustrated attempts to light up LED 6.

The basis of the experimenter deck has been used by myself and my friend to illuminate a full sized hardboard cow at our recent NZ agricultural field days.

A 555 timer driving four CD 4017's at different rates, in turn "firing" 30 2N 3055 transistors which in turn lit up 300 yellow red and green LEDs in different sequences and patterns to simulate, heart beat, hormone let-down, electrical stimulus and blood flow. Our cow was a good eye catcher and quickly earned the name R2-Moo2.

So you can see that from a passing interest your magazine has given me the incentive to go to further heights. Displays appeal to me and I can now see my way clear to carrying out some more complicated experiments.

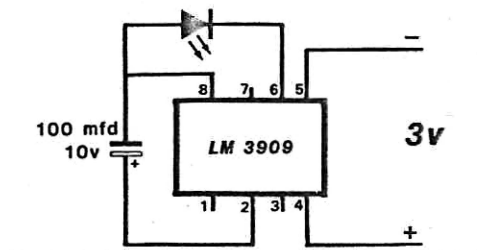
R. Barker  
Hamilton, NZ

## LM 3909 FLASHER

I was reading Issue 1, Page 16 and realized that a flashing light can be obtained by using an LM3909 integrated circuit. Although this IC is fairly expensive, it has the advantage of operating on a very low supply and consumes very little current.

I have used it on one of my radio control models and the unit weighs less than 1oz. It consumes less than .8ma and can be left connected to a couple of penlight batteries for the full extent of their life. The secret of the low current drain is in the slow charging of the capacitor then releasing its energy into the LED for a very brief period of time. This not only increases the LEDs efficiency but provides long life for any power source.

D. Wadham  
TeAtatu South, NZ



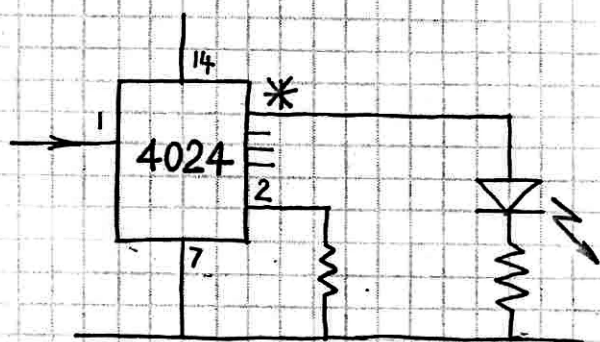
"I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

Isaac Newton

33

IN BLOCK 32 I MENTIONED DECODING. WHAT IS DECODING? HOW IS IT PERFORMED?

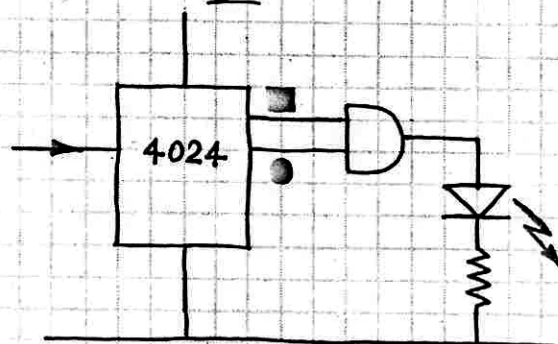
TAKE A CD4024 IC. IF WE REQUIRE A TIME DELAY FROM THIS IC, WE CANNOT SIMPLY CONNECT A LED (OR OTHER DETECTOR) TO THE LAST OUTPUT. FROM THE BINARY TABLE WE SEE THAT THE LAST OUTPUT (27) GOES HIGH ON THE 64<sup>th</sup> PULSE AND REMAINS HIGH UNTIL THE 128<sup>th</sup> PULSE. THUS BY USING ONLY THIS SINGLE OUTPUT THE MAXIMUM DURATION IS ONLY HALF OF THE FULL COUNT. TO ACHIEVE THE FULL TIME DELAY, WE NEED TO ATTACH A DETECTOR TO ALL THE OUTPUTS AND DETECT WHEN THEY ARE ALL HIGH. IF WE DETECT ONLY ONE OUTPUT AT A TIME WE CAN OBTAIN VALUES SUCH AS THE 2<sup>nd</sup> COUNT 4<sup>th</sup> 8<sup>th</sup> 12<sup>th</sup> 16<sup>th</sup> 32<sup>nd</sup> & 64<sup>th</sup> BUT NOT THE 127<sup>th</sup>. BY GATING A PAIR OF OUTPUTS WE CAN DETECT THE 3<sup>rd</sup> PULSE 5<sup>th</sup> 6<sup>th</sup> 9<sup>th</sup> 10<sup>th</sup> 12<sup>th</sup> 17<sup>th</sup> 18<sup>th</sup> 20<sup>th</sup> 24<sup>th</sup> 33<sup>rd</sup> 34<sup>th</sup> 65<sup>th</sup> 66<sup>th</sup> 68<sup>th</sup> 72<sup>nd</sup> 80<sup>th</sup> 96<sup>th</sup> BUT STILL NOT THE 127<sup>th</sup>. BY DETECTING 3 OUTPUTS AT ONCE WE CAN OBTAIN ANOTHER SET OF NUMBERS THIS METHOD OF DETECTION IS CALLED DECODING THE 4024.



DECODING ONE OUTPUT

\* FROM THE BINARY TABLE IN BLOCK 32 WE SEE THE LED WILL LIGHT ON THE:

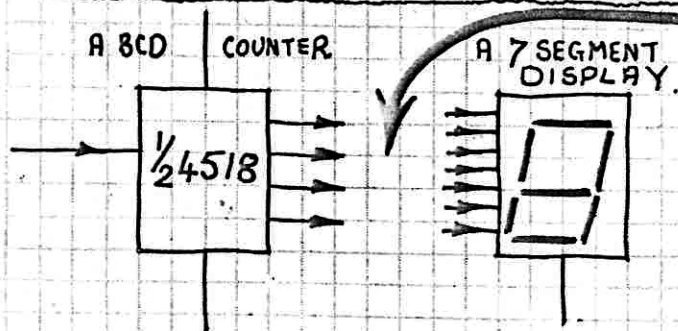
1 <sup>st</sup> PULSE	IF WE CHOOSE PIN 12
2 <sup>nd</sup>	" " " " "
4 <sup>th</sup>	" " " " "
8 <sup>th</sup>	" " " " "
16 <sup>th</sup>	" " " " "
32 <sup>nd</sup>	" " " " "
64 <sup>th</sup>	" " " " "



DECODING TWO OUTPUTS

BY CHOOSING OUTPUT PINS FOR ■ & ● WE CAN LIGHT THE LED ON THE 3<sup>rd</sup> PULSE 5<sup>th</sup> 6<sup>th</sup> 9<sup>th</sup> 10<sup>th</sup> 12<sup>th</sup> 17<sup>th</sup> 18<sup>th</sup> 20<sup>th</sup> 24<sup>th</sup> 33<sup>rd</sup> 34<sup>th</sup> etc. THE LED WILL LIGHT WHEN ANY TWO OUTPUTS DETERMINE A BINARY NUMBER. THIS DECODING CAN BE EXTENDED TO 3 OR MORE OUTPUTS.

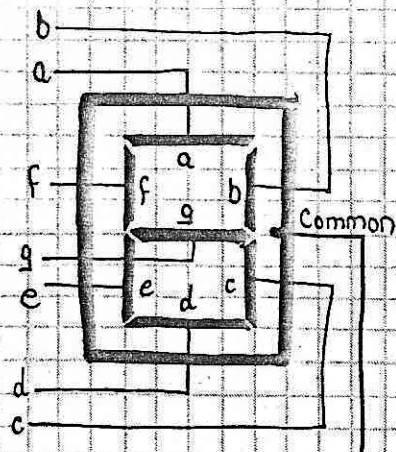
## DECODING A BCD COUNTER



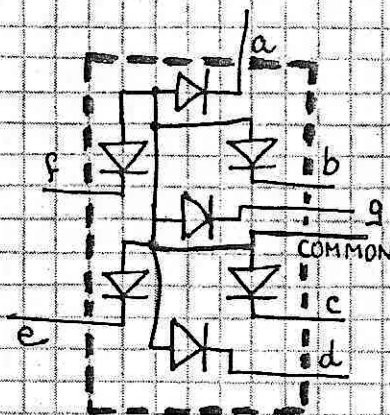
IT IS NOT POSSIBLE TO CONNECT A 4518 DIRECTLY TO A 7 SEGMENT DISPLAY AS A 4518 HAS 4 OUTPUTS AND THE DISPLAY HAS 7 INPUTS. WE NEED A DECODER, AN IC WHICH WILL CONVERT THE HIGHS & LOWS FROM A 4518 AND FEED THESE INTO A DISPLAY.



## A 7-SEGMENT DISPLAY

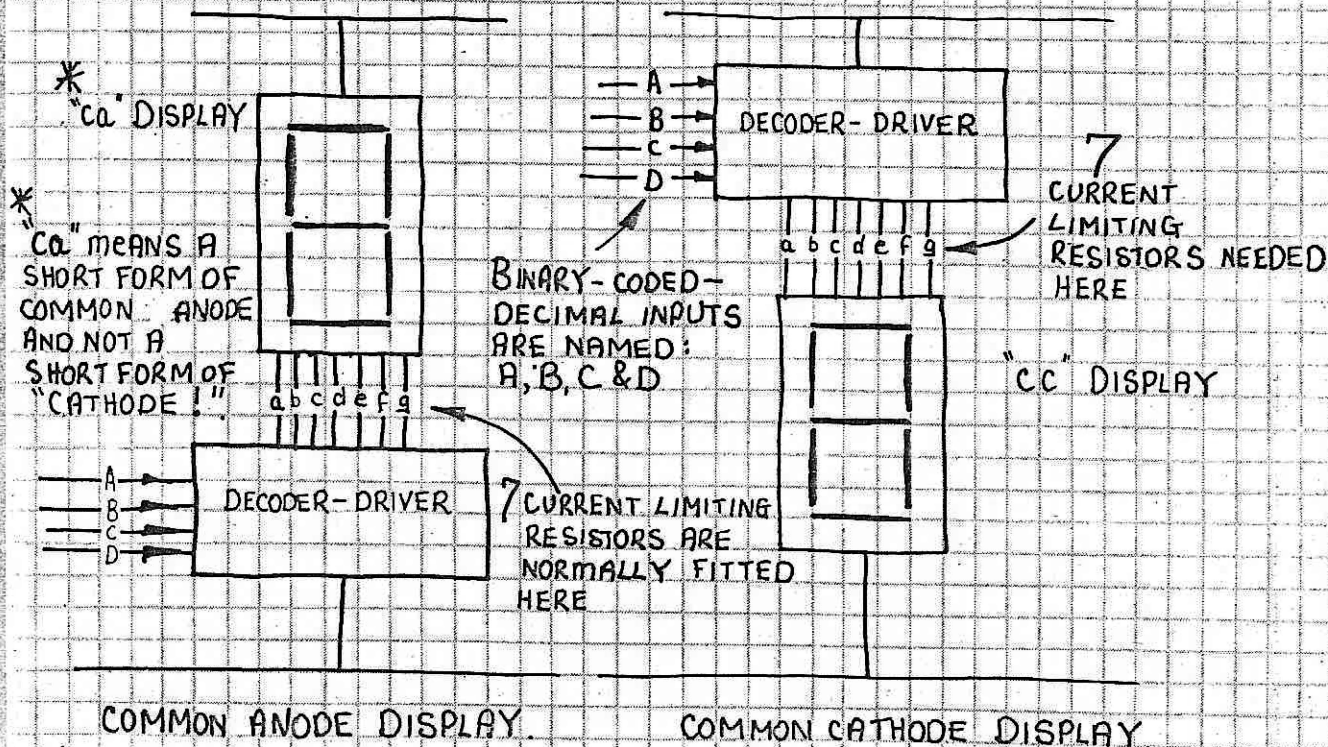


A 7-SEGMENT DISPLAY CONTAINS SEVEN RECTANGULAR LEDS. IF ALL THE ANODES ARE CONNECTED TOGETHER IT IS CALLED A COMMON ANODE DISPLAY.



HOW THE DIODES ARE ARRANGED TO GIVE A COMMON ANODE DISPLAY.

IF ALL THE CATHODES ARE CONNECTED TOGETHER IT IS CALLED A COMMON CATHODE DISPLAY. ONE CANNOT BE CONNECTED IN PLACE OF THE OTHER.

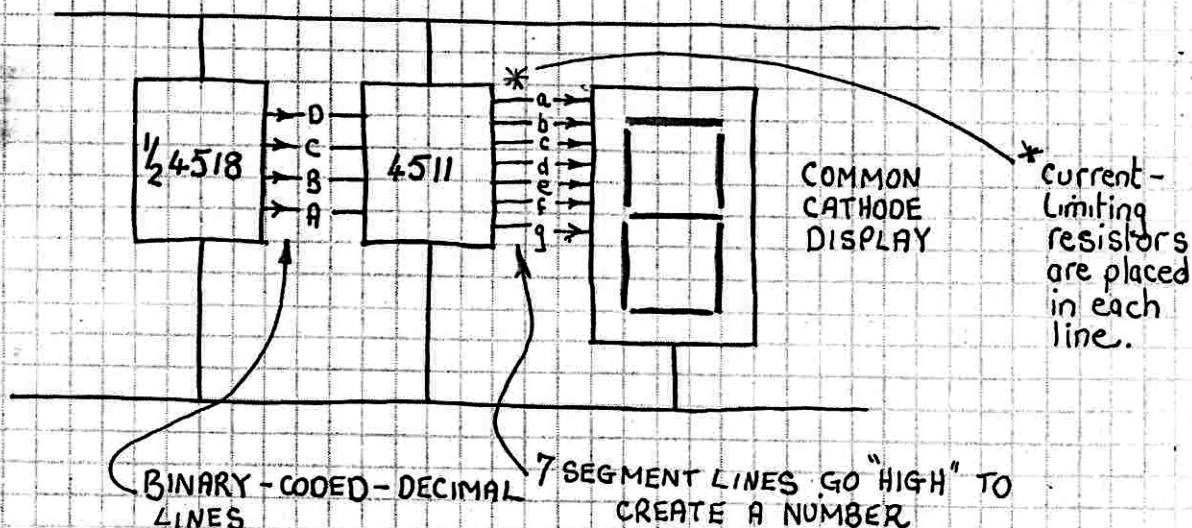


A COMMON-ANODE DISPLAY WILL NOT TAKE THE PLACE OF A COMMON CATHODE DISPLAY. IT WILL EITHER NOT WORK AT ALL OR INCORRECT SEGMENTS WILL LIGHT UP. ALTERING THE WIRING WILL NOT BE SUFFICIENT AS THE LEDS ARE CONNECTED IN OPPOSING DIRECTIONS INSIDE THE DISPLAY ITSELF.



3.3

A SUITABLE IC TO FIT BETWEEN THE COUNTER AND DISPLAY IS A CD 4511. IT IS CAPABLE OF TAKING ONE CODE (BCD) AND CONVERTING TO ANOTHER CODE (7 SEGMENT DISPLAY CODE)



LINES DCBA REPRESENT THE BINARY LOGIC LINES FROM THE COUNTER TO THE DRIVER IC.  
LINES a,b,c,d,e,f,g REPRESENT THE SEGMENT LINES FROM THE DRIVER TO THE DISPLAY.



TO CREATE A 5 ON THE DISPLAY WE KNOW ITS BINARY NUMBER IS: 

D	C	B	A
0	1	0	1

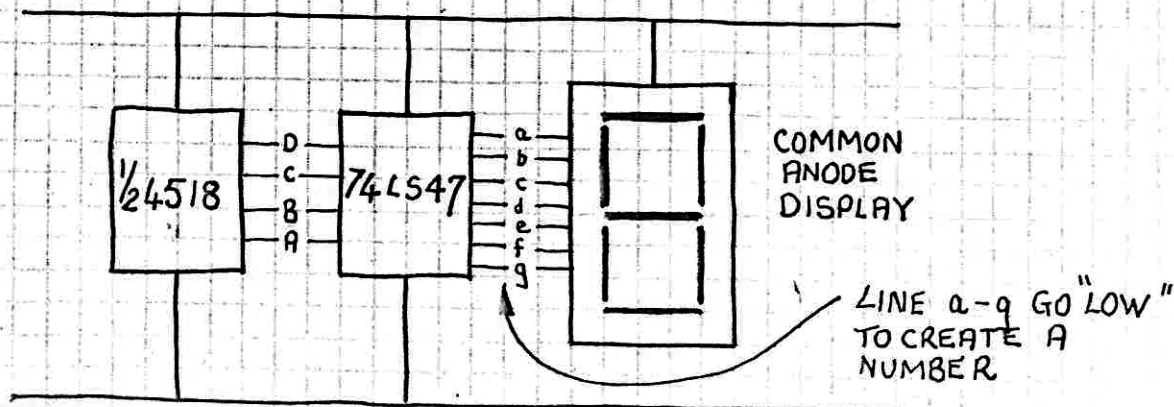
 THIS MAKES D=0 C=1 B=0 A=1

THE 4511 WILL ACCEPT THESE INPUT LEVELS AND SUPPLY THE 7 OUTPUT LINES THUS:

a=1 (HIGH) b=0 (LOW) c=1 (HIGH) d=1 (HIGH)

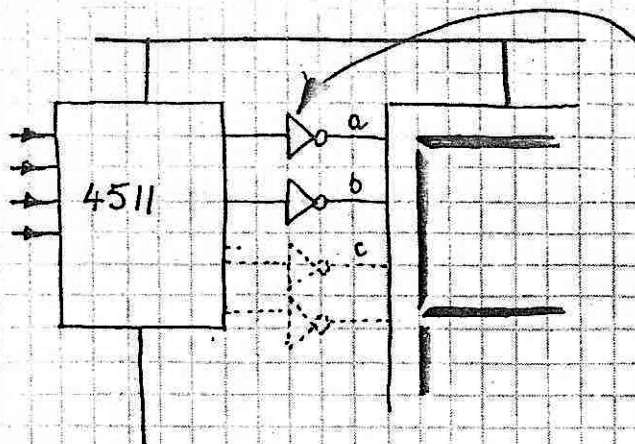
e=0 (LOW) f=1 (HIGH) g=1 (HIGH) & THE NUMBER 5 WILL BE DISPLAYED.

IF YOU WISH TO USE A COMMON ANODE DISPLAY, IT WILL BE NECESSARY TO CHANGE THE DECODER/DRIVER



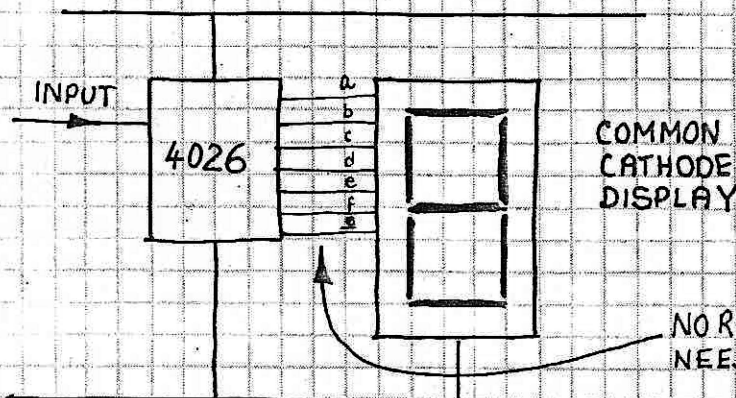
36

ALTERNATELY THE 4511 WILL DRIVE A COMMON ANODE DISPLAY VIA 7 INVERTERS AS SHOWN:

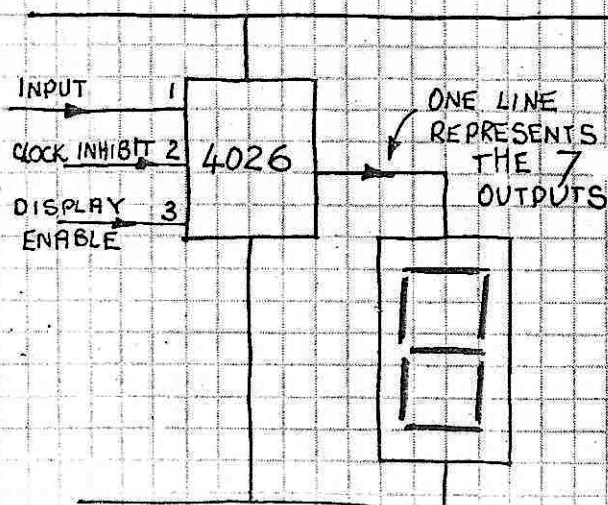


THIS ARRANGEMENT CAN OFTEN BE IMPRACTICAL AS INVERTERS COME "SIX IN A CHIP" AND WE NEED 7!

WE CAN REPLACE THE ABOVE COMBINATION OF  $\frac{1}{2}$  4518 & 4511 WITH A SINGLE IC. A CD 4026. IT IS A COMBINATION COUNTER, DECODER AND DRIVER IN A SINGLE CHIP. IN ADDITION IT HAS BUILT-IN CURRENT LIMITING TO PERMIT DIRECT DRIVE TO A DISPLAY WITHOUT THE NEED FOR SEVEN CURRENT-LIMITING RESISTORS.



THIS CIRCUIT WILL COUNT 0 → 9

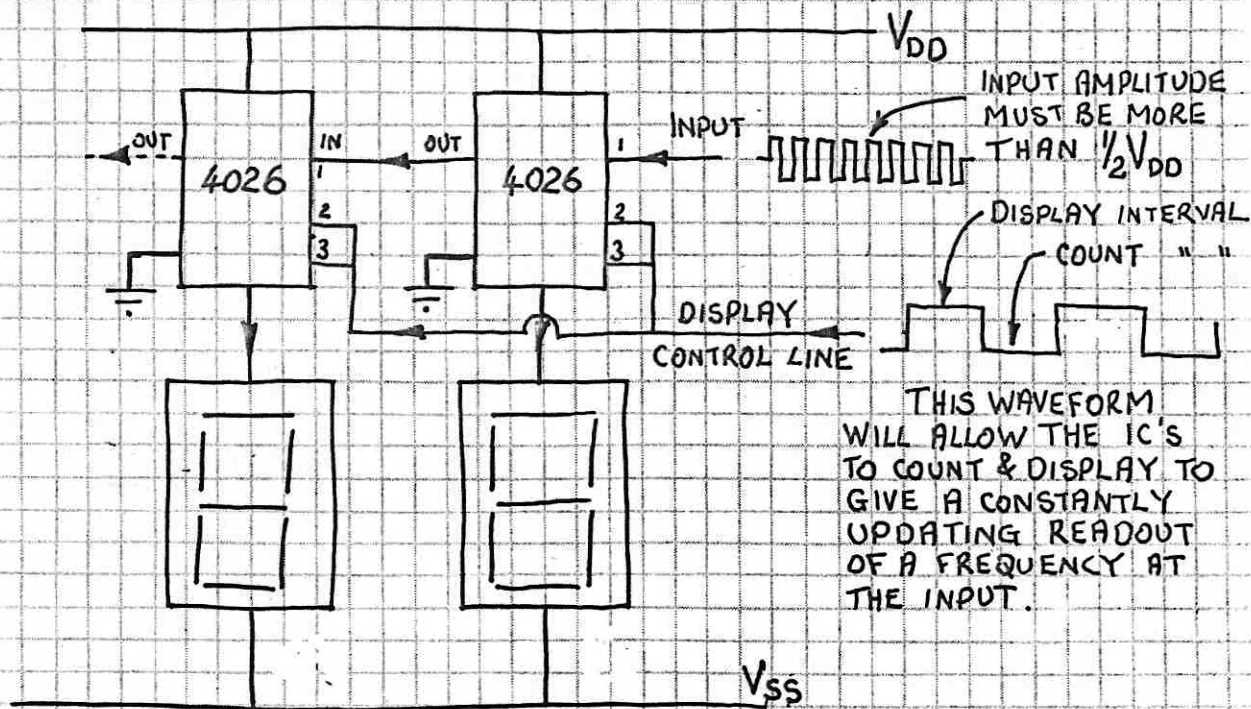


WHEN THE CLOCK INHIBIT PIN 2 IS HIGH IT WILL PREVENT THE IC COUNTING ANY INPUT PULSES. A LOW ON PIN 2 WILL ALLOW THE IC TO COUNT.

A LOW ON THE DISPLAY ENABLE PIN 3 WILL SHUT OFF THE DISPLAY. IT DOES THIS BY PRODUCING A LOGIC LOW ON ALL OUTPUTS. A HIGH ON PIN 3 WILL PRODUCE A BRIGHT DISPLAY.

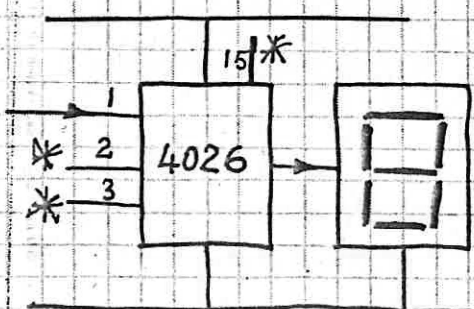
37

PINS 2 & 3 ON THE 4026 CAN BE WIRED TOGETHER TO PROVIDE A SIMPLE COUNT-AND-DISPLAY EFFECT. IT WORKS LIKE THIS: PINS 2 & 3 ARE WIRED TOGETHER AND KEPT LOW. THE IC WILL COUNT INTERNALLY & THE DISPLAY WILL BE CUT OFF. IF THE PAIR IS NOW TAKEN HIGH THE COUNT WILL FREEZE AND THE DISPLAY WILL SHOW THE TOTAL NUMBER OF PULSES. THE 4026 IC & DISPLAY CAN BE JOINED TO ANOTHER 4026 IC & DISPLAY TO COUNT UP TO 99 OR EXTENDED EVEN FURTHER. THIS IS CALLED CASCADING.



### CASCADING 2-4026's

BY TAKING PINS 2 & 3 ALTERNATELY HIGH & LOW AT 5Hz THE CIRCUIT ABOVE IS CAPABLE OF COUNTING FREQUENCIES UP TO 1,000 COUNTS PER SECOND. THE INPUT IS SHOWN AT THE RIGHT HAND SIDE AND THE COUNT PROGRESSES TO THE LEFT TO CREATE A "FORWARD READING" DISPLAY. A 2 UNIT DISPLAY OPERATING IN THIS ARRANGEMENT WILL DISPLAY "TENS" AND "HUNDREDS" AS THE COUNTERS COUNT THE INCOMING CYCLES FOR 100ms ( $\frac{1}{10}$  Sec) AND DISPLAY FOR 100ms. THUS THE DISPLAY IS UPDATED EVERY 200ms AND APPEARS AS A BLINKING DISPLAY AT THE RATE OF 5 TIMES PER SECOND.



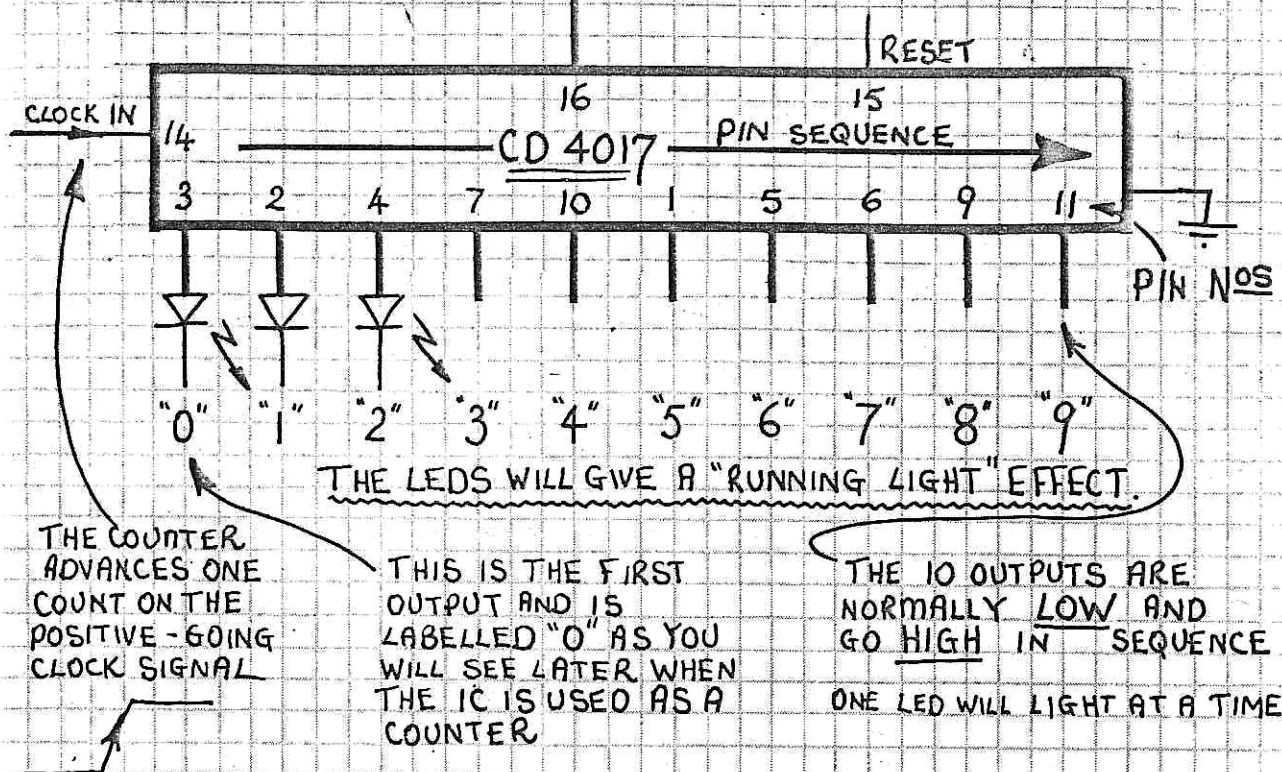
\* PINS 2, 3 & 15 MUST NOT BE LEFT "OPEN" OR "FLOATING". THE HIGH IMPEOANCE OF THESE THREE INPUTS WILL PICK UP STRAY SPIKES & NOISES AND CAUSE THE COUNTER TO "HUNT" AND CHANGE STATES. A 100K OR 1M RESISTOR TO LOW OR HIGH IS NECESSARY ON PINS 2 & 15. THE DISPLAY WILL NOT ILLUMINATE SINCE PIN 3 IS NOT CONNECTED HIGH.



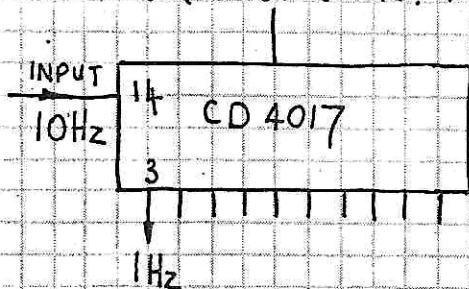


## THE DECADE COUNTER

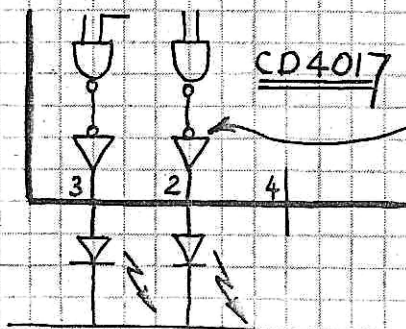
ONE OF THE MOST VERSATILE COUNTERS IS THE CD 4017. IT IS CAPABLE OF COUNTING UP TO 10, & HAS 10 SEPARATE OUTPUTS.



IF A FREQUENCY OF 10Hz IS APPLIED TO THE INPUT PIN, IT IS EQUALLY DIVIDED BETWEEN THE 10 OUTPUTS. THUS THE FIRST OUTPUT (OR ANY OTHER OUTPUT) WILL TURN ON AND OFF ONCE PER SECOND. THIS SHOWS THE CHIP HAS DIVIDED THE FREQUENCY BY 10. WE CALL A CD4017 A DECADE COUNTER/DIVIDER



A CD4017 CAN BE USED AS A DIVIDER

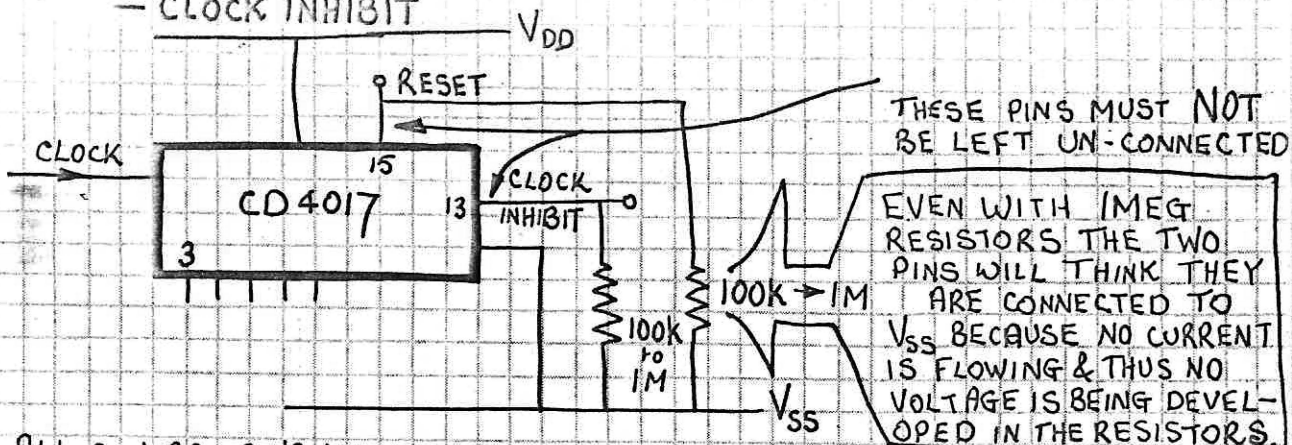


EACH OUTPUT OF A 4017 HAS A BUFFER CAPABLE OF DRIVING A LED. THE CIRCLE ON ITS INPUT INDICATES IT RECEIVES A LOW DURING QUIESCENT CONDITIONS AND CHANGES TO THIS LOW STATE ON THE FALLING EDGE OF THE WAVEFORM. SINCE THIS GATE IS INSIDE THE IC ITS OPERATION DOES NOT CONCERN US, AND THIS FALLING WAVEFORM IS ALSO INTERNAL

3)

THE COUNTER HAS 2 OTHER IMPORTANT PINS:

- RESET
- CLOCK INHIBIT



ALL CONTROL PINS MUST BE CONNECTED TO EITHER HIGH OR LOW. THEY CANNOT BE LEFT FLOATING. THIS APPLIES TO THE RESET & CLOCK INHIBIT PINS. WHEN THE RESET IS CONNECTED LOW AS SHOWN, THE IC WILL COUNT THE FULL 10 OUTPUTS.

WHEN A VOLTAGE ABOVE  $\frac{2}{3}V_{DD}$  (ABOUT 6V) OR A PULSE OF SHORT DURATION IS APPLIED TO THE RESET PIN IT WILL RESET THE IC TO THE FIRST OUTPUT (PIN NUMBER 3). IF A HIGH IS MAINTAINED, THE COUNTER WILL REMAIN AT PIN 3.

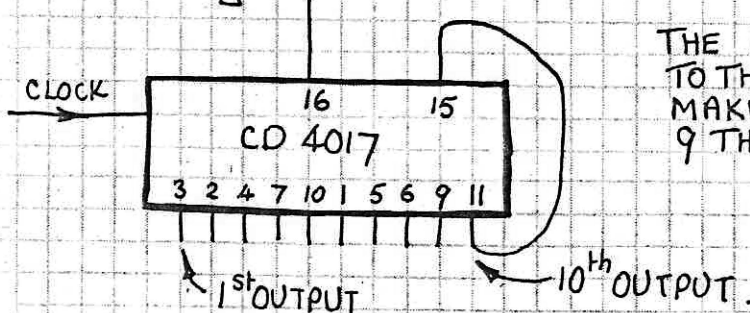
WHEN THE CLOCK INHIBIT PIN IS CONNECTED LOW AS SHOWN, THE IC WILL COUNT THE FULL 10 OUTPUTS.

WHEN THE CLOCK INHIBIT PIN IS CONNECTED HIGH THE COUNTER WILL "FREEZE" ON THE OUTPUT IN OPERATION.

THE 100K OR 1M RESISTORS KEEP SPIKES FROM ENTERING THE CONTROL PINS WHILE AT THE SAME TIME GIVES THE PIN A HIGH IMPEDANCE PATH TO ANY CONTROL VOLTAGES.

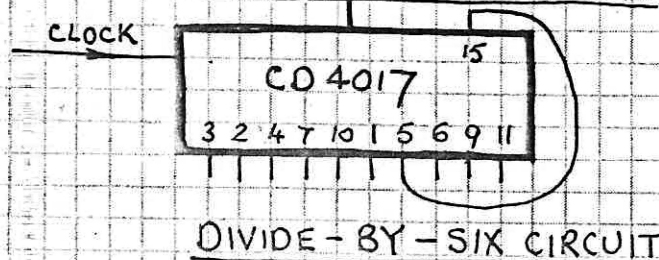
A CD 4017 WILL DIVIDE BY 9 or 8 or 7 or 6 or 5 or 4 or 3 or 2.

A Divide-by-nine circuit:



THE 10<sup>TH</sup> OUTPUT IS CONNECTED TO THE RESET PIN. THIS WILL MAKE THE COUNTER COUNT TO 9 THEN RESET.

DIVIDE-BY-NINE CIRCUIT



THE 7<sup>TH</sup> OUTPUT IS CONNECTED TO THE RESET PIN. THIS WILL MAKE THE COUNTER COUNT TO 6 THEN RESET.

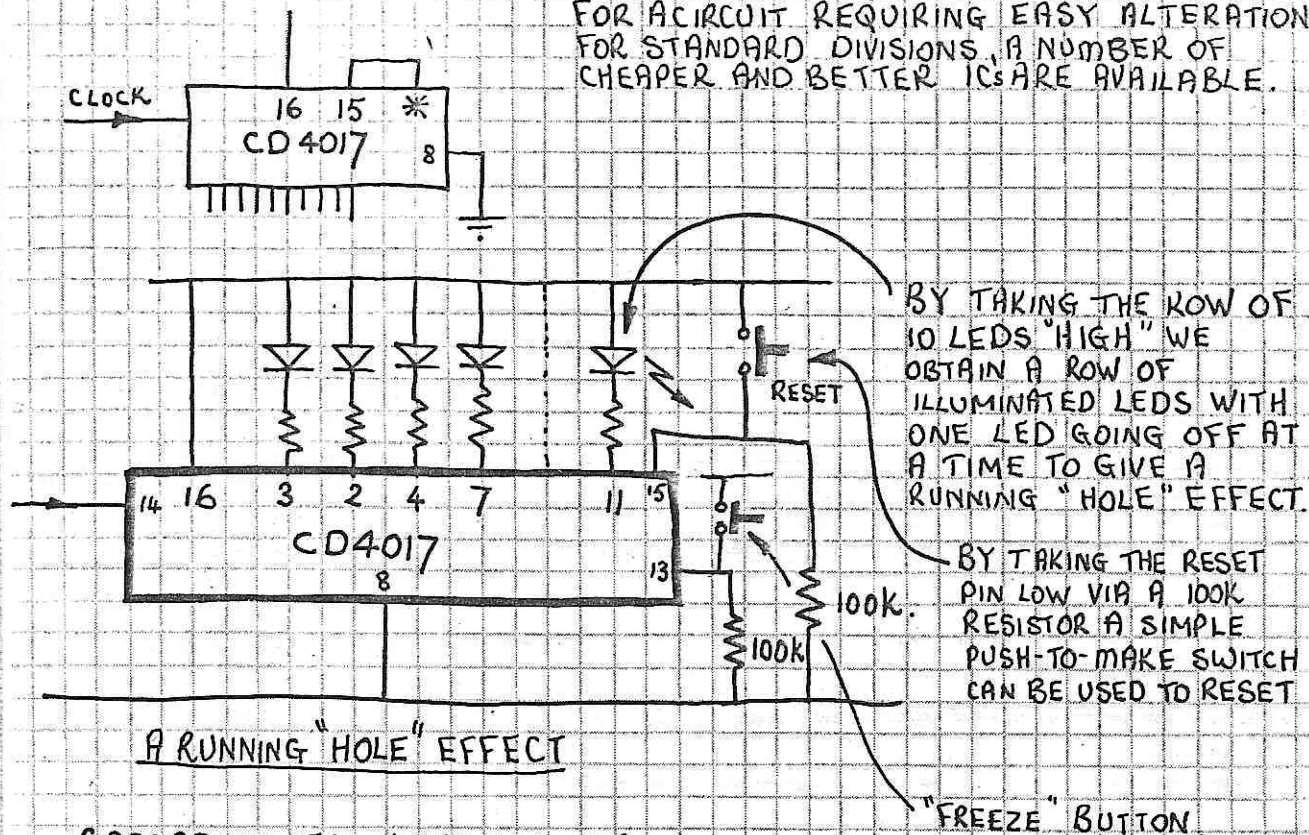
DIVIDE-BY-SIX CIRCUIT



## 40

"DIVIDE - BY - N"

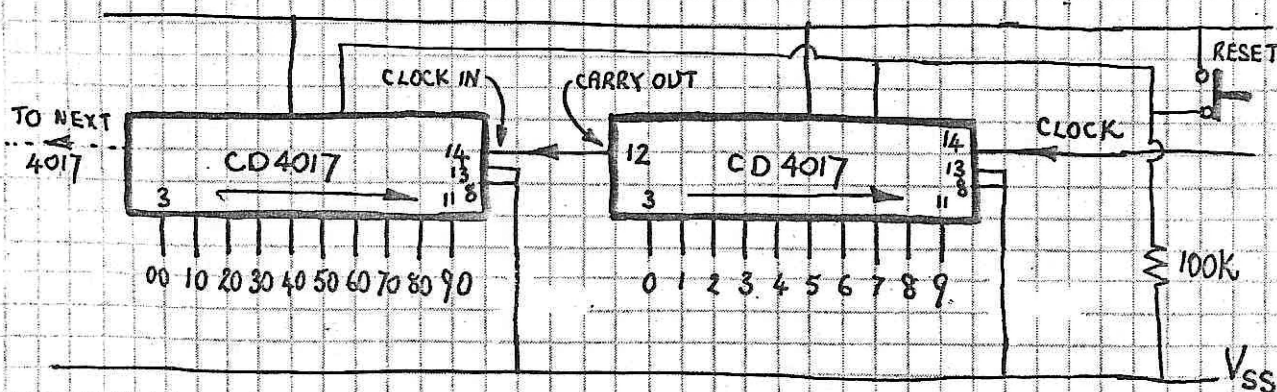
"DIVIDE-BY-N" \* A DIVIDE-BY-N CIRCUIT FOR THE CD4017  
REQUIRES THE  $N+1$  OUTPUT TO BE CONNECTED  
TO THE RESET PIN. THIS CIRCUIT IS HANDY FOR ODD DIVISIONS OR  
FOR A CIRCUIT REQUIRING EASY ALTERATION.  
FOR STANDARD DIVISIONS, A NUMBER OF  
CHEAPER AND BETTER ICs ARE AVAILABLE.



BY TAKING THE RESET  
PIN LOW VIA A 100K  
RESISTOR A SIMPLE  
PUSH-TO-MAKE SWITCH  
CAN BE USED TO RESET

"FREEZE" BUTTON

### CASCADING THE 4017 COUNTER:



TWO (OR MORE) 4017 COUNTERS CAN BE CASCADED TO PRODUCE A COUNTER. IDEALLY IT CAN BE A PRE-SET COUNTER IN WHICH THE OUTPUTS ARE DIODE GATED TO A SIGNALLING DEVICE SUCH AS A LAMP OR BELL. THE CIRCUIT IS ARRANGED TO PRODUCE A FORWARD READING DISPLAY AND ANY NUMBER OF CHIPS CAN BE ADDED TO INCREASE THE RANGE. THE CARRY-OUT PIN IS CONNECTED TO THE CLOCK PIN OF THE NEXT COUNTER. THE RESET AND CLOCK INHIBIT PINS MUST BE TAKEN TO EARTH POTENTIAL ( $V_{SS}$ ). THE ADVANTAGE OF INCLUDING THE 100K RESISTORS ALLOWS A SIMPLE PUSH-TO-MAKE SWITCH TO BE INCLUDED IN THE CIRCUIT FOR "RESET" OR "FREEZE".



# TV Servicing Part III

Ramblings from our disheartened serviceman.....

Everything happens in cycles. Some weeks you are snowed under with work, then a complete lull comes to give you time to think "why on earth am I in this crazy job?" Who else offers instant in-home service for an enormous range of equipment designs and then has to account for the last dollar? The only consolation comes when a whole string of sets require nothing more than a handful of cheap components to get them back to almost brand new. This was the week that was. It started on Monday with a fairly new Philips set showing a dark picture. Now you all know how I have boosted Philips designs to the hilt. And how I haven't yet had to replace a tube in a Philips set ..... well this could be the turning point. After checking the voltages to the accelerating anodes on the tube and the drive voltages I came to the conclusion that an internal leak was affecting the brightness level. I hauled out my trusty B&K Picture Tube Rejuvenator and looked up the Swe-Check picture-tube adaptor list. This is the most valuable list to be compiled. It lists all the known picture tubes in Australian sets and the adaptor required to give them a "hit". Since it was one of the newer inline tubes, I needed a rarely-used adaptor No 115. Sure enough, as with all tubes tested, the tube showed an almost perfect reading. For all my experience, I have not yet had a sensible reading on a tester, showing the actual condition of the tube.

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**"Be patient, you're dealing  
with Murphy's Law!"**

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Quite often an almost unwatchable tube will record three guns to be better than 50% emission while a couple of quite good picture tubes gave an almost undetectable reading. Just purely reading the static emission levels is not good enough. A number of other factors affect the resulting brightness. Although the actual phosphor screen gives very little trouble, the accelerating voltage and the video current available from the video amplifiers has considerable effect on the overall brightness.

Back to our case. The tube tested alright and since everything had been checked for voltage levels, it had to be the tube. When I set the instrument to rejuvenate, the three guns showed a considerable tendency to short between electrodes when a slightly higher voltage was impressed. The clever feature of the B&K tester is in the safety rejuvenating system. When the rejuven button is pressed, the filament is extinguished. This prevents the cathode from heating up to red hot as this would burn all the thorium-type material off the cathode

and reduce the tube to scrap. One at a time the particles between the elements were burnt away. After the majority of these particles were disintegrated, I removed the adaptor and replaced the picture tube board. On turning on the set the picture was absolutely perfect. The brightness control could be placed at half level, the colour control was reduced and the focus had come back into the picture. It was quite pleasing. This was one of the first times I had used that particular adaptor and

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**"Some days every  
thing goes wrong!"**

---

so the result was quite gratifying. Two other jobs that day were also similarly encouraging. The first of these was a General 43cm set. I have sold hundreds of these sets and have only needed to service about 15 out of three hundred in the past four years. That is an incredible record. And when you think of it, all the sets suffer from only three faults.....Most of their faults begin with intermittent symptoms and sure enough, by the time I got to the house, the sets were behaving normally. The complaint with the set was a picture jumping up from the bottom and narrowing in height. After waiting for about 15 minutes for this to occur, I finally tried the old trick of hitting the top of the set.

The picture immediately collapsed to a narrow line. Another simple job. The soldering on the vertical module pins had become dry. Even though the soldering connections are extra robust the heating and contracting of the module finally breaks the joint. A slight knock will heal the connection for a while but finally it becomes so annoying that the customer calls in the technician. If it is allowed to persist in the collapsed state for too long, the dropper resistor to the push-pull amplifier will burn out. Fortunately, in this case, this load resistor was still intact and so the job required nothing more than a little re-soldering. The third job worth mentioning on the Monday involved a Pye colour set with lack of width. If you have ever seen inside a Pye set, it consists of two swing-out mother boards which have a feeble copy of the Philips design. After a few years in operation, the large signal board (carrying the horizontal output section) begins to show signs of wear. Many of the parts get too hot and begin to discolour the board and this in turn removes the printed overlay showing resistor and capacitor numbers, so that they become un-readable. Along with the overheating, some of the pins are carrying quite heavy currents, especially to the vertical and horizontal sections of the yoke. Over the years dry

joints begin to appear between the pins and PC board which can introduce a small resistance into the circuit. The other common fault occurs on the incoming supply pin. It eventually burns out completely resulting in no picture and no sound. The former fault was the complaint with the Pye set. Again I charged a small fee for the simple repair. By the time Thursday came, you guessed it, all the three sets had resulted in callbacks. The Philips picture tube fault had lasted just three days after which the picture had become too dull to watch, the General set had developed another fault, and the Pye set had collapsed to a white line. To some customers, it takes quite a bit of convincing that you haven't planned a time delay fault in their set or fitted faulty components. Many often refuse outright to pay any more for repairs and it would very soon become an awkward stalemate if you stood your ground. The Philips set was an obvious challenge and required full explanation as to the nature of the fault. When you see a fault like this as one in a thousand, you think how unlucky for it to occur to those who can least afford it. I always seem to find the most expensive fault happens to the nicest customers. The tube needed a second attempt at removing the built-up carbon deposits and I had to explain factually that the tube may or may not last the week. It was unfortunate but a premature failure like this is not the end of the set. The remaining portion of the set was still perfect and a new tube will keep the set going for another 5 years or more. This is the only way to approach the customer in the home. How could you possibly tell them that the cost of a new tube was not economics? How can you say "throw away a four year old set and buy a new one?" It's only when you go back to the work shop and find out the real costs of a new tube has gone up \$50

### ~~~~~ "Replacing the tube is just not economics" ~~~~~

due to the new sales tax and the waiting time for a replacement is at least two weeks that you think "well maybe you are being squeezed out of business." Some technicians may invest in a re-gun tube but from my experience, they cause more trouble and headaches than they are worth. From the outset they are not perfect. They rarely purify fully and they have a very bad tendency to go soft within a year or two. Most of the re-guns I have come across are back at the unwatchable state within 18 months.

And that is false economy.

I am still waiting on the customers call to let me know how the set is going. One interesting fact about picture tubes is worth mentioning here. If this Philips' customer was to leave the set on 24 hours a day and never turn it off, the picture tube would re-

main perfect. It's not the use of the set which poisons the cathodes, it is the non-use. I have proven this fact with a previous set which suffered from a similar complaint. I connected the filament of the picture tube to a 6 volt mains transformer which was directly coupled to the power point. This meant the filament of the tube remained alight 24 hours a day and gave them the advantage of an instant picture. The result was that the tube lasted for months and months while the customer began to save up for a replacement tube. This is not always the case, but nine times out of ten the ageing of the tube takes place when the set is not being watched. This accounts for the anomaly as to why sets which are used by children for long periods of time suffer from the least number of faults. Now about the General set. After fixing the height problem, the customer called back a day later to say the brightness was disappearing every few minutes and even with the brightness turned up fully, the only parts of the picture which were discernable were the reds and blues. They seemed to infer something about the fact that this did not happen till I took the back off the set and did some soldering the day before. As it turned out, the luminance delay line was intermittent. (It is a long blue rectangular box containing a specially wound coil of fine wire). The fault with these lines is due to the potting mixture encapsulating the wires. The rate of expansion between the copper wire and the potting compound is different and this causes the wire to fracture inside the unit. Fortunately they are not expensive and once you have fixed this type of fault before, it is a routine replacement. Fortunately the customer was understanding and was prepared to pay a little extra for the component. In these circumstances I generally charge only for the parts and show them the components I have removed. This generally turns out to be a lot less than even the cost of a service call from one of the larger firms, but then this is the service expected from a small firm.

Lastly let's look at the Pye set with collapsed vertical. The picture did not collapse completely but tended to drop more from the top of the screen than from the bottom. A small amount of crimping occurs with this fault and the suspect components are invariably the output transistors. Originally the output transistors were 2N4232 or AY8171 but as these are no longer available, the substitutes are 2SC1104 or 2SC1025.

It is always a wise move to replace both transistors in the one operation, as this fault will overload both devices. As a matter of interest, the lower transistor on the heatsink drives the upper portion of the picture and the upper transistor operates the lower half of the screen. This is just one of the layout design faults I try to avoid when designing a project as it causes inconvenience and confusion for others who might have to perform troubleshooting. Consideration to these small points makes the difference between a good design and a failure.

These facits are self-levelling. They actually work themselves out over a period of time. Look at the number of TV makes which are with us today and compare this with about 40 different manufacturers competing on the market just five years ago. When the next generation of designs comes on the market, you will see yet another fall-off in makes, as the more progressive manufacturers keep abreast with the times and the struggling suppliers fail to adopt the more advanced technology into their sets.

This weeks examples are just a microscan of the ever increasing problems with colour sets. Even though the failure rate is considerably less than for black and white sets, the faults seem to come in pairs. Quite often you just complete one fault and another will develop. It's just the luck of the game but it tends to eat into the meagre profits and tries our resources to the limit.

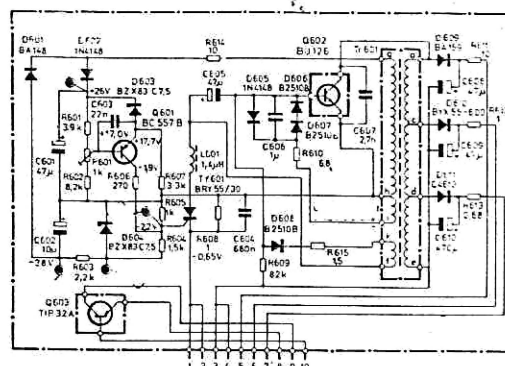
### THE SWITCH MODE POWER SUPPLY

In part III of TV SERVICING I outlined the circuit for a switch mode power supply. I mentioned the two methods of approach to repairing these units. For the initial servicing, an overhaul is the best approach. Most of the electrolytics will have dried out over the years and will prove to be a source of intermittent troubles. The original diodes are also very troublesome and a number of dry joints are generated in the circuitry. Once all these are removed, the power supply is very reliable.

### SMPS FAULTS

FAULT	CURE
BU 126 chopper keeps blowing	<ul style="list-style-type: none"> <li>- dry joints all over PC board</li> <li>- hairline cracks near high wattage components</li> <li>- loose transformer connections</li> <li>- charred PC board</li> <li>- 2700pf tuning capacitor open circuit</li> <li>- 1k trim pot intermittent</li> </ul>
Damaged BRY 55 thyristor	<ul style="list-style-type: none"> <li>- Always due to faulty chopper transistor caused by one of the above</li> </ul>
Short circuit 47/350v electrolytic	<ul style="list-style-type: none"> <li>- check one of the above causing high output voltage</li> </ul>
Power supply whistles	<ul style="list-style-type: none"> <li>- replace D 606 and D 607 in the base circuit of the BU 126 with MR 812 or BYX 55/600v high speed diodes</li> </ul>
Low output (about 150v)	<ul style="list-style-type: none"> <li>- replace two 47/63v electrolytics and 10mfd 63v electrolytic</li> </ul>
Sides of raster bending and moving and this slowly moves down the screen	<ul style="list-style-type: none"> <li>- replace 470mfd 350v electrolytic on the Mother Board outside the module.</li> </ul>
Slight noise from power supply	<ul style="list-style-type: none"> <li>- replace 1mfd 250v capacitor on Mother Board near 1 amp fuse</li> </ul>
Dot pattern on low channels	<ul style="list-style-type: none"> <li>- Replace 47mfd 350v electrolytic</li> </ul>
Power supply does not always start up	<ul style="list-style-type: none"> <li>- Replace 47mfd 250v electrolytic.</li> </ul>

The Luxor Power Supply Module provides an ideal reference for discussing SMPS faults. They provide



Luxor Switch Mode Power Supply circuit

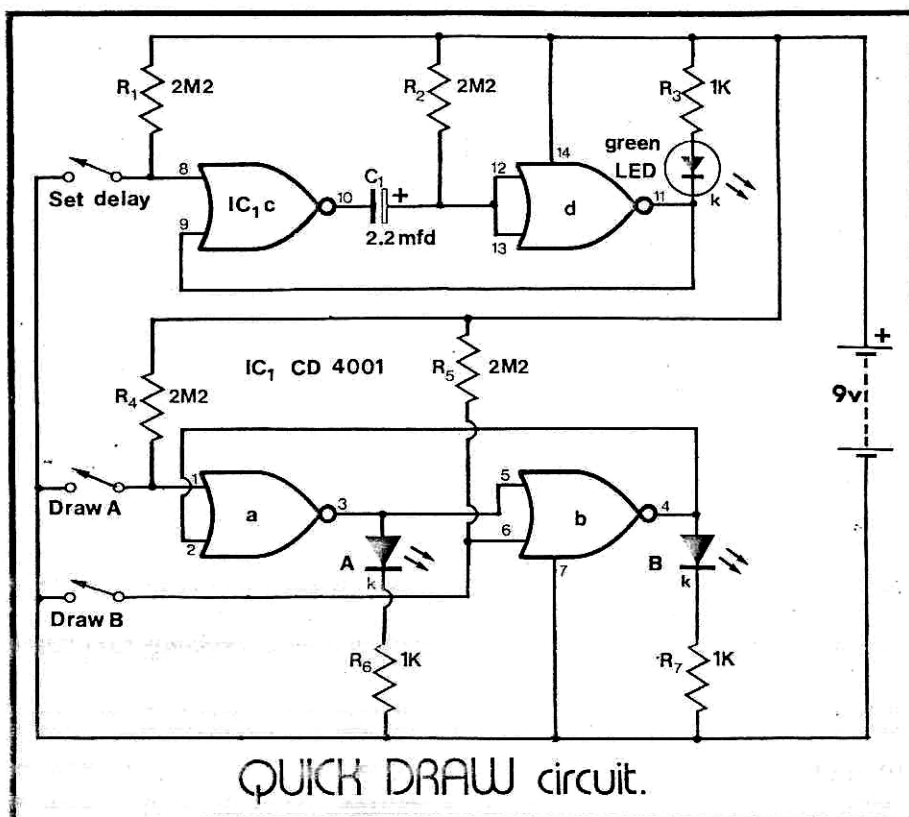
considerable service for field technicians due to the high break-down rate. The power supply itself is well designed; it is the choice of components which prove to be the downfall. Once these components are replaced, the supply operates very satisfactorily. We will assume you have overhauled the power supply as suggested in the last section. And for one reason or another the power supply still does not operate satisfactorily. Here is a list of features to locate the possible source of trouble.



# Quick Draw

A simple circuit showing the versatility of a quad NOR gate

**Project cost: \$3.50**



QUICK DRAW circuit.

This is a game for two players. It's rather like an up-to-date version of HIGH NOON. The object of the game is to fire your 'gun' before your opponent. In this version we have substituted the gun for a switch and in place of the bullet we use a LED.

This project will give you an indication of your reaction time matched against your partner. Your "draw time" is calculated from the time a green LED lights up, to the time your red LED is lit. Suppose you take switch A. This will connect and control LED A. The aim is to press switch A before your partner presses switch B. If you succeed in doing this, you automatically lock off his circuit and only LED A will light up. For both players to have an equal chance at "drawing", the green LED comes on after a delay of a few seconds. Either player can press the SET DELAY to begin the timing as both will have to wait a few seconds for the green LED to light up...this way it gives both a fair chance.

## PARTS LIST

R1	resistor	2M2	1/2 watt
R2	"	2M2	"
R3	"	1k	"
R4	"	2M2	"
R5	"	2M2	"
R6	"	1K	"
R7	"	1k	"
C1	electrolytic	2.2mfd	10v
LEDs A&B	5mm red LEDs		
Green LED	3mm		
IC1	CD 4001		
	9v battery clip		
	9v battery		
	springy brass strip		
	"Quick Draw" PC Board		

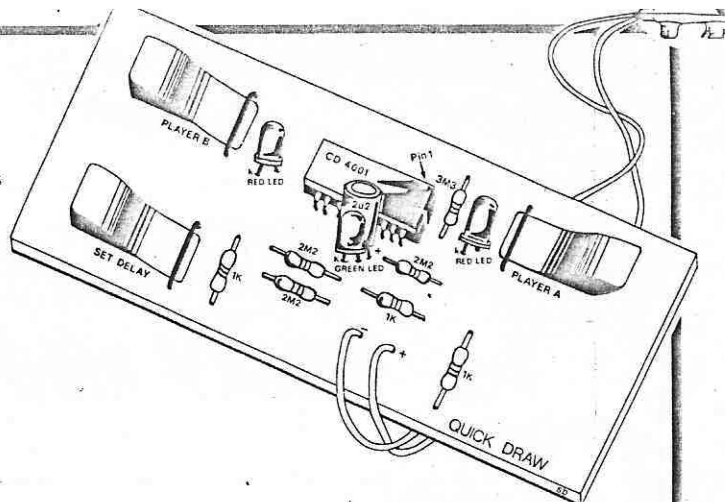
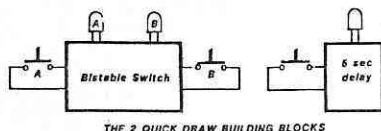
## HOW THE CIRCUIT WORKS

The circuit consists of two separate sections. Gates "a" and "b" form a bistable switch while gates "c" and "d" form a TIME DELAY circuit. Beginning at the lower part of the circuit, LEDs A and B are connected to two NOR gates. These are interconnected so that only one output can be HIGH at any one time. For either output to be HIGH, its two input gates must be LOW. This can only occur when one switch is pressed AND the other LED is not lit. This circuit is not a LATCH. The LEDs are only lit while the switch is pressed. This means that we do not need a reset to turn off the red LEDs.

The other half of the integrated circuit is used for the delay. We can analyse the upper circuit or building block as follows: When the power is applied, one input of the first gate is HIGH via  $R_1$  and its output will be LOW. Capacitor  $C_1$  will gradually charge up via  $R_2$  and after a few seconds will supply a HIGH to both inputs of the second NOR gate so that its output becomes LOW and the green LED lights up. The circuit will remain in this state ready for play. When the SET DELAY switch is pressed, the output of the first NOR gate will go HIGH and  $C_1$  will discharge via the input protection diodes of the second gate. The output of the second NOR gate does not alter at this stage. When the SET DELAY switch is released, the discharged capacitor  $C_1$  is brought to deck and this produces a LOW on pins 12 and 13. The second NOR gate responds to this and turns off the green LED. Capacitor  $C_1$  gradually charges via  $R_2$  until the threshold voltage of about 5v-6v is reached to change the state of the second NOR gate and light the green LED again. This is a signal to press your switch and lock in a result on LED A...before your opponent fires LED B.

## CONSTRUCTION

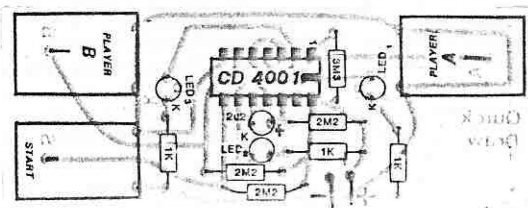
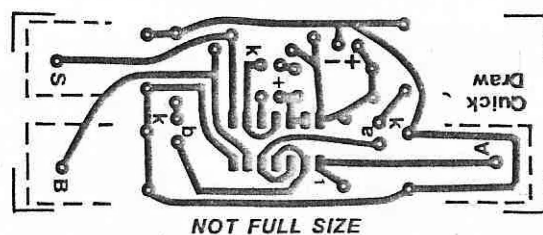
Construction is made easy on a small Printed Circuit Board. For economy we have used fabricated switches mounted directly on the board. The switches are made from thin springy brass .005" thick and cut to fit over the pattern marked on the underside of the board: If you wish to house the project in a zippy box, you can connect hook-up wire from the PC board to the switches mounted on the lid of the box. When a project is neatly laid out such as this one, I prefer to see the components. If it is a mess, I hide it away in a box!



The circuit has a couple of other features which I won't mention. I will let you find these out for yourself. When you construct the PC board, touch the underside of the circuit with your fingers and see what effect it has on the LEDs. In fact you might even come up with the unusual characteristic which we discovered by chance. Since the two parts of the circuit are completely separate, you can use either the delay or the bistable switch for another project.

## MAKING THE SWITCHES

The three switches are made from springy brass strip .005" thick. It is cut to 8mm wide. Each switch is 25mm long. The point contact on the board is made from an unused resistor lead. Solder it in position and bend it over the top of the board. Make up 3 staples of wire to fit over the brass strip and into the holes on the PC board. Solder each to the PC wiring and then to the brass strip to make a firm anchor. Bend the strip upwards and check the contact. "Switch bounce" will not affect this project so don't worry about very clean contacts.

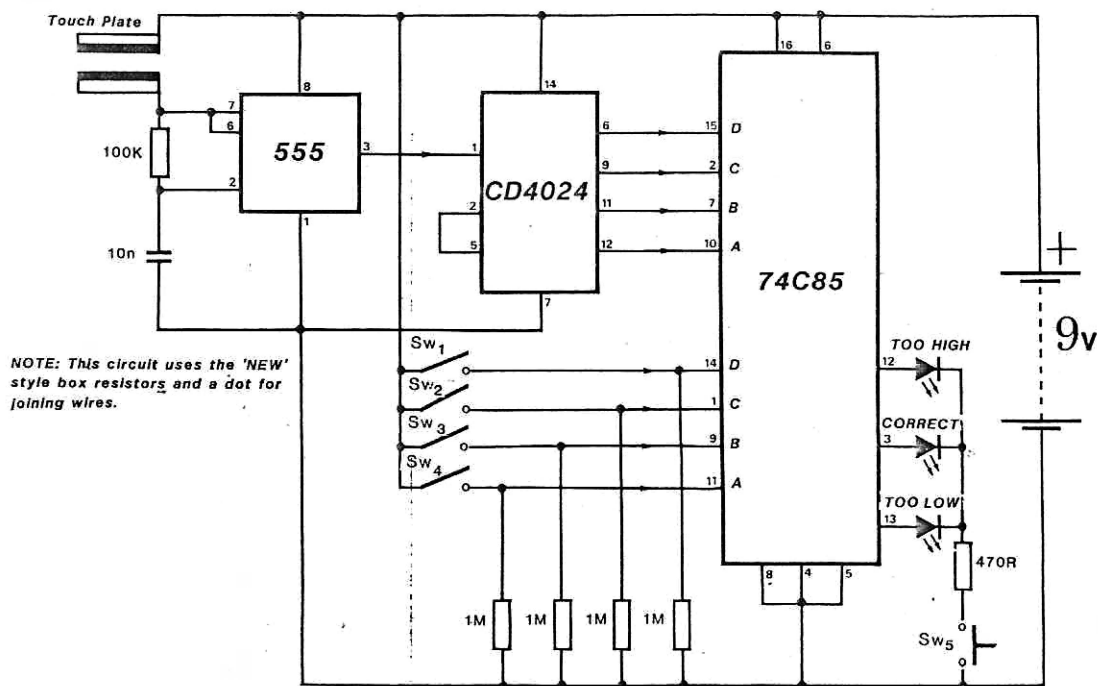


# Continuing the series EXPERIMENTER BOARD

## BINARY HIGH-LOW GAME

### Project 8

By P. Fyffe 3126



**PROJECT COST \$2**

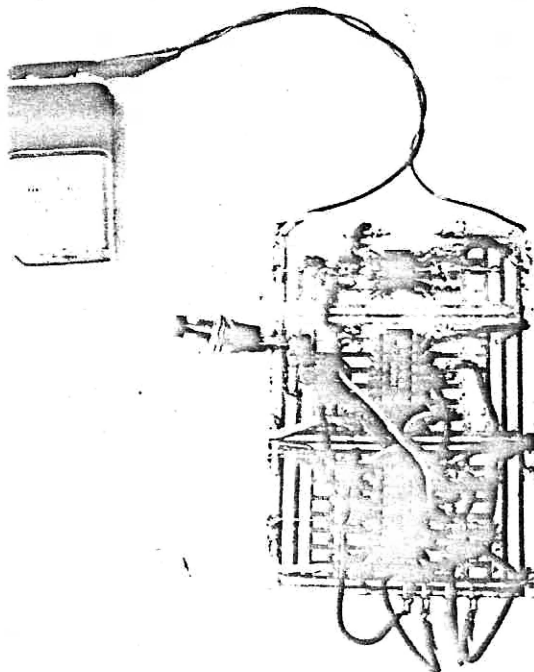
**AFTER BUILDING PROJECT 7**

Our BINARY HIGH-LOW GAME is a simple game and is intended as an introduction to comparators.

A comparator such as the 74C85 compares two four-bit words and determines if one is greater than, equal to or less than the other. Since a four-bit word can be expressed in 16 different ways, this IC is capable of accepting 16 different possibilities and comparing this information with a second four-bit word to display an answer.

The idea of the game is to guess "what number the Binary Counter thought of". By using the flying leads and the molex pins, this number is entered into the second half of the comparator chip. The circuit will then tell you if your guess is high, low or exact. The unknown number entering the first half of the chip is generated by the CD 4024 Binary Counter IC in which its first four outputs are connected to the first half of the comparator. Four binary bits are called a four-bit word or NIBBLE.

A second nibble is generated by the flying leads and Molex pins. If the lead is left flying, a logic Low ("0") is present on the input pin of the comparator. When the lead is connected to a Molex pin, the IC records a HIGH ("1").





In issue 3 we presented a BINARY COUNTER on the Experimenter Board. This was slightly modified in issue 4 for the SHOOT GAME in which we moved the LEDs to the centre section so that the gating transistor circuit could be assembled in the last segment.

For this BINARY HIGH-LOW GAME we need only remove the gating transistor section and the board is ready for the 74C85 magnitude comparator.

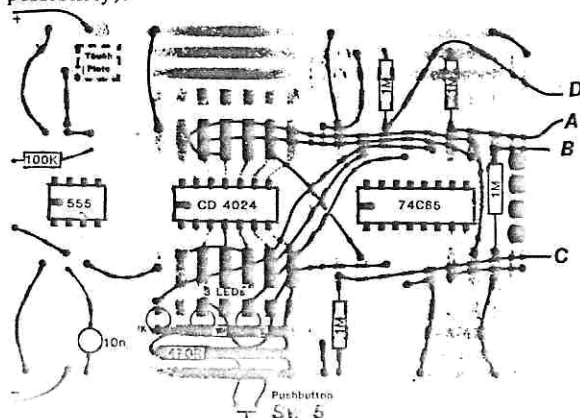
These projects must be assembled in sequence if you intend to really understand digital circuitry. Merely by looking through and studying a circuit will not make you fully ofay with its mode of operation. Lots of points crop up while you are handling the parts and these can never be fully expressed in a constructional article. Very often the most informative part of the project is hunting through the completed layout trying to find the incorrect connection or dry joint. If you are really intent on learning . . . construct EACH STAGE.

The 74C85 is a four-bit magnitude comparator which will perform comparison of two four-bit words and determines whether they are "greater than" or "equal to" or "less than" each other. The IC provides a HIGH on one of the three outputs as an indication of this information. The CMOS version in our project is NOT a pin-for-pin equivalent of the 74LS85 TTL comparator or the low power 74L85 or the 74LS85. If you are only able to obtain these versions, you will need to use different pin connections and operate the circuit from 5v by using a 6v supply and placing a diode in the positive rail. The current limiting resistor for the LEDs will need to be reduced to 270R or 330R for the lower voltage.

## HOW THE CIRCUIT WORKS

When you place your finger on the touch pads on the top right hand corner of the board, the resistance of your finger allows a very small current to flow and supply a voltage to the pins 7, 2 and 6 of the 555 oscillator. Even with resistances as high as 100k, the IC will begin to clock. The speed of this clocking is not important as we are only interested in the fact that it is loading a number into the comparator via the 4024 IC.

The binary counting IC CD 4024 is wired with pin 5 connected directly to the rest pin 2. This means the IC will reset on the 15th count and this will be the highest number available. This will give us a possible choice of 16 numbers which can be entered into the comparator. (Assuming we include zero as a possibility).



## PARTS LIST

R1	resistor	100k	1/4 watt
R2	"	1M	"
R3	"	1M	"
R4	"	1M	"
R5	"	1M	"
R6	"	470R	"
C1	capacitor	10n	100v
IC1	timer IC	NE 555	
IC2	binary counter	CD 4024	
IC3	magnitude comparator	74C85	
LED1 to LED 3 3 or 5mm LEDs			
Push-to-make switch			
4 Molex pins			
Hook-up wire			
battery snap			
9v battery			
"EXPERIMENTER BOARD 31C's"			

Lets look at how the comparator works. Suppose the counter were to stop on 1000. In binary terms this would correspond to D being HIGH, C being LOW and A being LOW. The first "1" on the left hand side corresponds to the D output and is the most significant digit.

If we load our guess into the machine by connecting leads D, C and B and push switch Sw<sub>5</sub> we will get an answer of too HIGH. If you remove lead B the reading will still be too HIGH. But on removing lead C the centre LED will light up to show the correct value. It is now your requirement to invent a method for selecting the correct combination "within 4 attempts."

## CONSTRUCTION

This project is an extension of the binary counter project. The third section of the board accommodates the magnitude comparator, 3 LEDs and the set of switches. Follow the lay-out diagram and you should have no trouble completing the circuit. The 7 LEDs from the binary counter project can be left on the board if you wish. Out-put 5, the fifth LED, will need to be taken back to pin 2 so that only the first four outputs are clocked. This means the other 3 LEDs will not illuminate and can be taken off the board and used as the HIGH, CORRECT AND LOW LEDs.

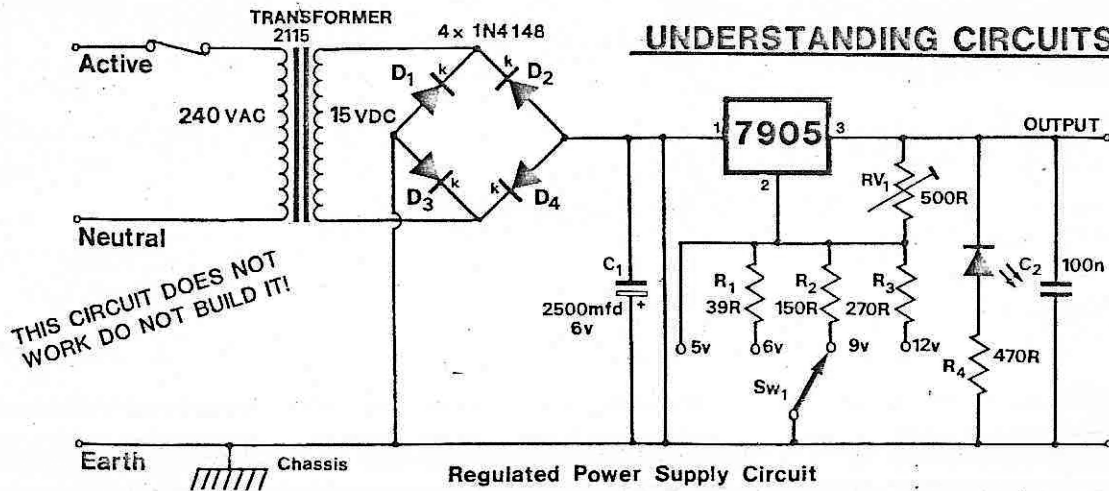
If you have a selection of coloured 3mm LEDs, you can use red orange and green for the outputs to make the game a little brighter. Even two red LEDs and a green LED will give you instant recognition of the result.

## GETTING IT GOING

The first two IC's will be ready and operating as they formed the previous project. The comparator IC will be our main concern. There is one important point worth remembering about the four flying leads. They produce a HIGH when connected to the Molex pins. Cut out the overlay and paste it onto the chip to show the outputs D, C, B and A.

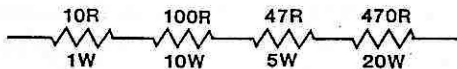
# TEST YOURSELF.

1 THIS POWER SUPPLY CIRCUIT CONTAINS AT LEAST 10 FAULTS  
CAN YOU LOCATE THEM?

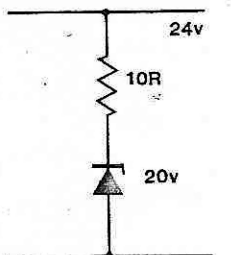


## UNDERSTANDING CIRCUITS

2 Which resistor will burn out first when the combination is connected to a high voltage.

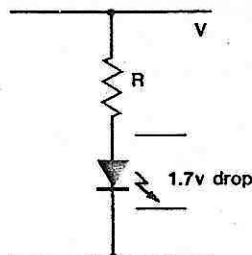


3



A 20v zener diode is connected to a 24v line via a 10 ohm resistor. What is the current in the zener diode?

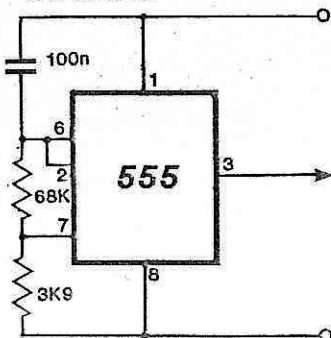
4



A light emitting diode is connected to a high voltage rail via a dropping resistor. Calculate the value of the resistor when the voltage is: (a) 10v (b) 15v (c) 20v. The LED requires 10mA.

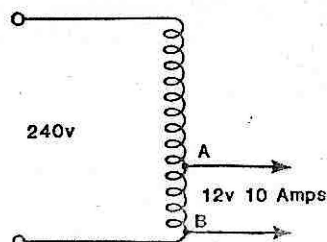
5

can you list the faults in this circuit?



6

An auto transformer is tapped at 12v and is required to deliver 10 amps to a load. What is the approximate current in winding 'a'?



All too often we take it for granted that a circuit will operate. Possibly because we have faith in the designer or maybe because we don't know how the circuit operates. Try your skill at picking the faults in these circuits and determine the working values in the other two circuits.....

The auto transformer can be treated as a normal double-wound transformer for this situation. The output wattage is 12x10 watts (actually volt-amps) so that the input must be 120 watts, assuming the transformer is 100% efficient. This gives us an input current of 240/120 = 5 amps.

Supply voltage 10v.  
Voltage across the resistor = 10 - 1.7 = 8.3v  
 $R = 8.3 / 0.01 = 830 \text{ ohms}$   
Supply voltage 15v:  
Voltage across the resistor = 15 - 1.7 = 13.3v  
 $R = 13.3 / 0.01 = 1330 \text{ ohms}$   
Supply voltage 20v  
Voltage across the resistor = 20 - 1.7 = 18.3v  
 $R = 18.3 / 0.01 = 1830 \text{ ohms}$   
Obviously you will use the nearest preferred value for the dropper resistor.  
We cannot find anything incorrect with the circuit excepting that it is up-side-down!

1. Fuse - no rating  
2. Diodes D2D4 around the wrong way  
3. 4x EM 401 not 1N 4148  
4. 2500mfd up-side-down  
5. 7905 is a negative regulator  
6. Regulator numbering should be 132  
7. LED reversed biased  
8. 15VAC not DC  
9. 6v electrolytic should be 25v  
10. Short-circuit wire near electrolytic.  
The 470 ohm resistor has the lowest wattage rating for the current flow.  
The voltage across the resistor is 24-20v = 4v. From ohms law  $I = E/R$  = 4/10amp = .4amp

ANSWERS

# COUNTER MODULE

Part II

Adding these sensors to  
the COUNTER MODULE:

## HALL EFFECT SOUND

### WHAT IS "HALL EFFECT"

For over 100 years, scientists have known about the effect of passing a conductor through a magnetic field. This is how our electricity is generated. It applies to our enormous generators right down to the dynamo on our bicycle. However when the magnet stops rotating, or the conductor stops moving, the electricity ceases. It was not until recently that scientists found that when a current carrying conductor was placed in a magnetic field, this field would modify the current flowing even though the conductor was not moving. This voltage developed was extremely minute and is known as the HALL EFFECT. It varies for different materials and the microscopic voltage must be amplified and passed to a trigger so that it can be used in a switching circuit. This action is now available in a package the size of a standard transistor. The block diagram fig. 1. shows the functions within the HALL device. The tables list the most important parameters and typical applications.

Since a HALL EFFECT DEVICE produces only a switching action, you may be tempted to say "Why not use a reed switch?". If you knew the limitations of a reed switch, you would realize the value of this new device. A reed switch has a very limited life. Even with a life expectancy of 1 to 10 million operations, this becomes fairly short if we use it for detecting shaft rotations or large-scale counting. In addition, a reed switch has a fairly slow speed of operation and produces a lot of switch bounce which would need to be removed before it could be used in digital circuits. The HALL device has a Schmitt trigger built into the package to produce a very clean on/off signal. It also has a guaranteed life expectancy of 12 billion operations and can operate at speeds in excess of 100,000 pulses per second. With these figures there is no comparison. A reed switch is purely suited for detecting the opening of a window or door in a burglar alarm system.

We have selected two types of HALL switches. We found them to be almost identical in sensitivity and suitability. The "transistor looking" HALL switch is a TL 170C and costs about \$1.70. The other looks like a thick film construction and cost a little more at about \$2.35. Both are available from Stewart

### TYPICAL APPLICATIONS

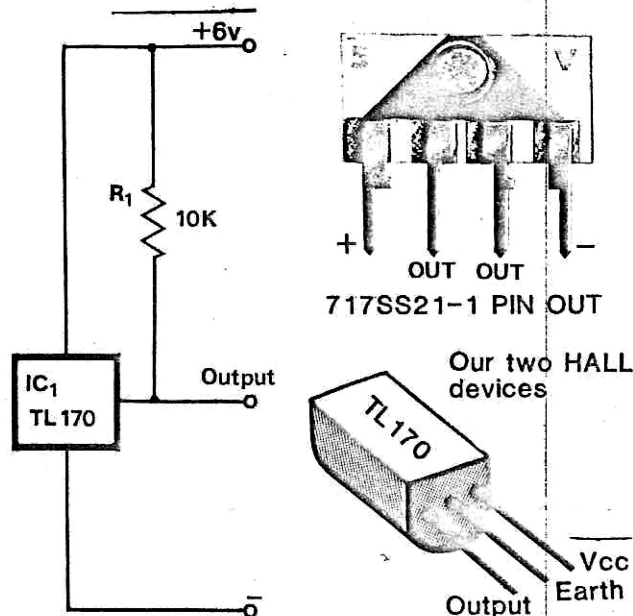
Linear and Rotary motion detection  
Position or Movement detection  
Current sensing  
Limit switch  
Switch Matrix  
Industrial machinery  
Vending Machines  
Medical and Scientific equipment.

### RATINGS:

Supply voltage  $V_{cc}$  ..... 7v  
Output voltage ..... 30v  
Output current ..... 20ma  
Magnetic flux density....unlimited

Electronics, 44 Stafford St., Huntingdale, 3166.  
(Their origin of manufacture would account for the difference in price.)

Both switches are very easy to connect to the counter module. The TL 170 requires a 10k resistor as shown in figure 2 to supply the output transistor with rail voltage. We are using only low voltage in our circuit and the maximum  $V_{cc}$  of 7v will not be exceeded. If you intend to use a higher voltage, it will be necessary to add a zener reference and filtering. The voltage on the output transistor is limited to 30 volts and is capable of supplying 20ma. You will see that the output transistor is quite separate from the HALL sensing circuit and this is the reason for the two different voltage levels.



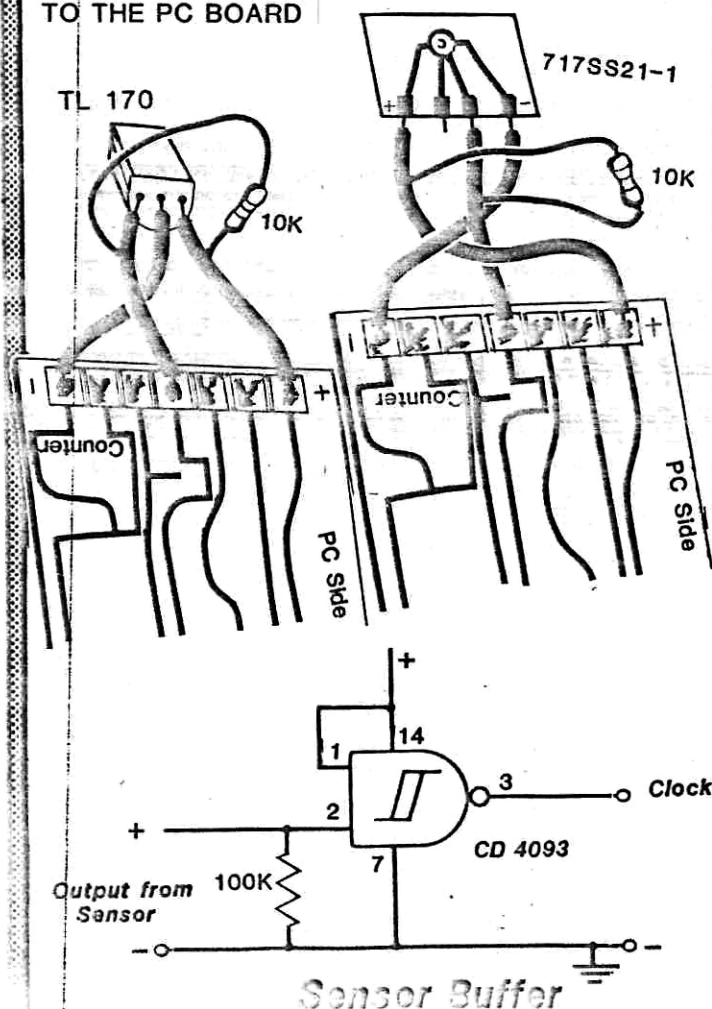
To trigger the HALL device, almost any magnet will be suitable. Try robbing one from a magnetic badge of a small motor. Set up the following experiment and see how the HALL device responds to magnetism.



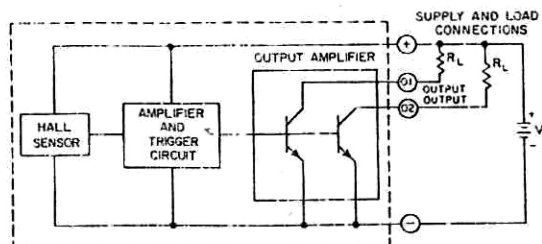
## DETECTING ROTATION

The HALL EFFECT sensor is ideal for detecting shaft rotations. It can be set up fairly quickly with a magnet attached securely onto the shaft and the sensor placed alongside. The sensor should be mounted in a diecast box as shown in the diagram with the three leads clearly marked. Cut out an opening in the lid of the box about 2cm x 4cm and cover it with clear perspex or plastic from a blow-moulded bottle. We found the HALL device was only capable of detecting movement in one direction. This means that the magnetic tab will not be picked up when the shaft is rotating in the opposite direction. This can be awkward if you are sensing the tail shaft of a car or truck. To overcome this, place one tab in the NS direction longitudinally along the shaft and another tab in the opposite direction at the 180° mark. As the two tabs come around, the sensor will respond to only one tab. On reversing the truck, the other tab will record a pulse. The speed of rotation will only be limited to the centripetal force exerted on the magnet. The sensor is capable of detecting 100,000 revolutions per second. That's even faster than a high-speed dentists drill.

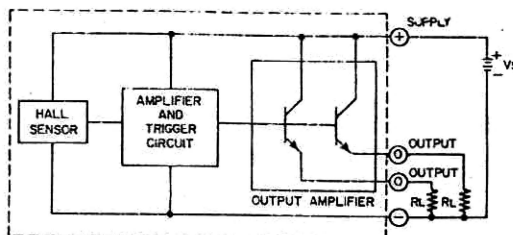
## CONNECTING THE SENSORS TO THE PC BOARD



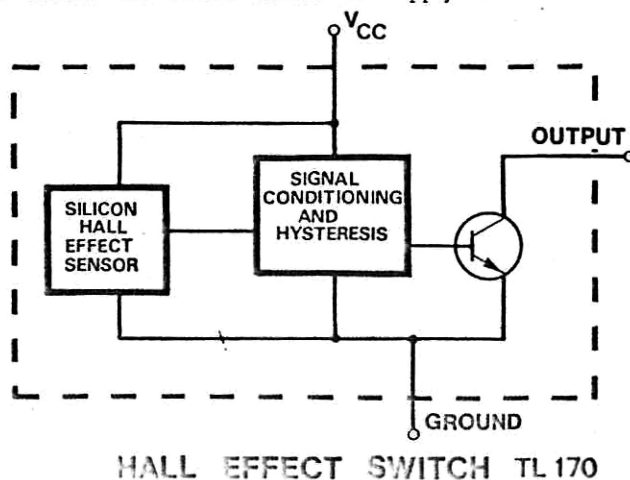
## CURRENT SINKING CIRCUIT



## CURRENT SOURCING CIRCUIT



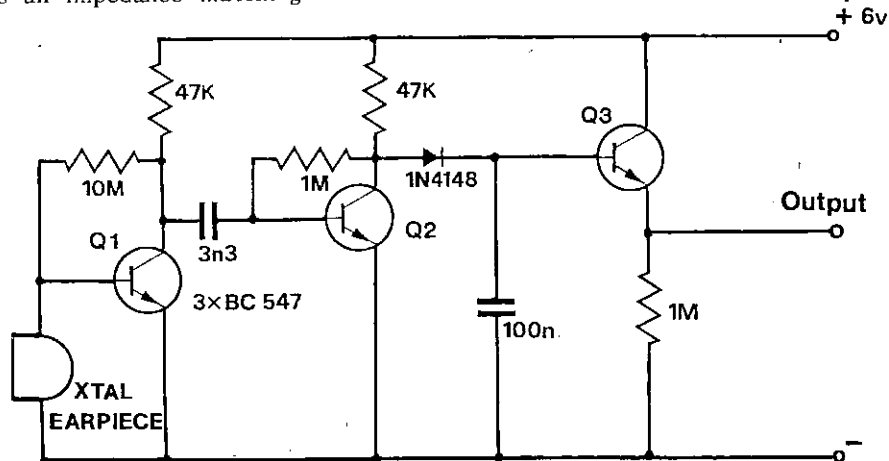
With either HALL device, mount it on a piece of Veroboard to prevent the leads from breaking, as the unit is handled. Fit the 10k dropper resistor and connect the three leads to the Counter Module PC board as shown. The sensitive face of the HALL device is shown upwards. Slide a magnet across the front of the sensor. Note the counter adds one unit count. Now move the magnet away from the sensor a very small distance and bring it back again. Notice the counter does not add a count this time. The magnet must be taken further away from the sensor and brought back again to register a count. This feature prevents the sensor from false triggering or "bouncing" as the magnet is moved past the sensor. If this feature was not included, a point would be reached by the magnet which would pulse the sensor an excessive number of times, even without the magnet moving. In magnetic terms this is called hysteresis and is electronically analogous to the Schmitt trigger. In fact a Schmitt trigger is incorporated in the sensor to give us this stable situation and completely remove any bouncing. An output transistor is integrated onto the silicon chip to enable the HALL device to supply about 20ma.



## SOUND

The sound detector circuit uses a crystal earpiece to pick up audible sounds and convert them into a reference voltage for Q3. The signal appearing at the base of Q1 is amplified and passed to Q2 via the 3n3 capacitor. Both Q1 and Q2 are self-biasing stages requiring only one resistor to give a slight turn-on voltage. Q2 will respond to the signal passing through the 3n3 and this will appear at the collector in an amplified form. The 1N 4148 diode rectifies this voltage and charges the 100n capacitor. This voltage is transferred to the 1M resistor via Q3 which acts as an impedance matching device to

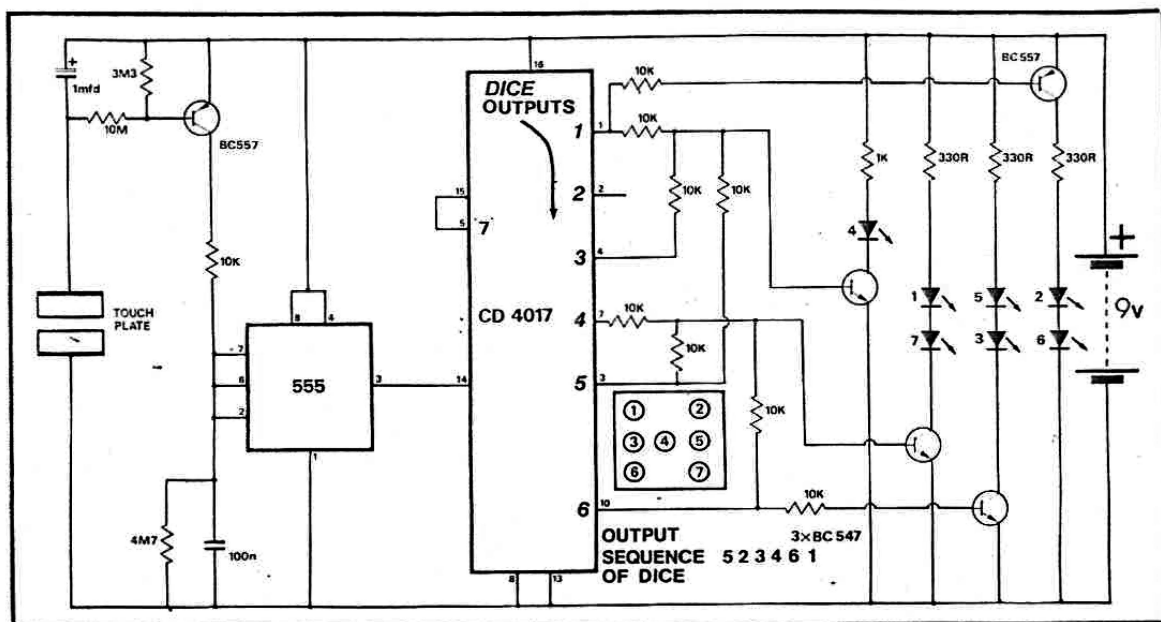
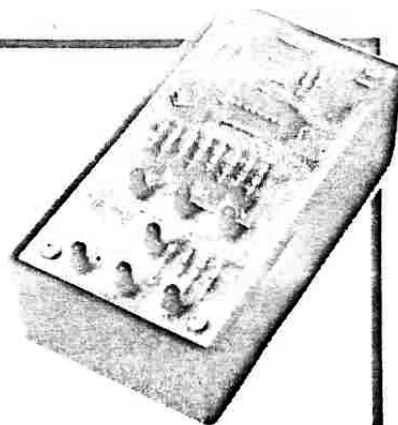
separate the capacitor from the load. This rising voltage will then trigger the Schmitt trigger which is made from one gate of a CD 4093 and will pulse the counter one count. The circuit is fairly sensitive and will respond to a whistle or clapping of the hands as one count. A natural time delay is provided by the discharging of the 100n capacitor so that the circuit cannot be pulsed any faster than about 5 cycles per second. The output from this circuit must be passed to a Schmitt trigger to clock the Counter Module. It does not have a fast rise-time and cannot be connected directly.



# LED DICE

WITH SLOW DOWN

A REALISTIC DICE WITH "TUMBLING" ACTION



This project combines the advantages of our other two dice projects. If you have built either one or both of the other models you will be very pleased with this improved version. It uses a realistic readout via seven LEDs and has a "slow down" feature. The LEDs are positioned on the printed circuit board in the same positions as the dots on a dice. The effect of the flashing of these LEDs simulates the rolling of a real dice in as much as the flashing slows down like a tumbling dice. Consequently what else could we call the project but LED DICE WITH SLOW DOWN. It fits neatly on top of a medium size zippy box with the printed circuit board mounted directly on top in place of the aluminum lid. It's another one of "neat little projects" which you will be pleased to show around. A small pre-printed panel can be placed under the LEDs before soldering them onto the board to add realism to the project. Since the LEDs have a low level of illumination, they may be lost in bright sunlight but in a normally lit room they will be most effective. All the parts for this project are readily available and should cost about \$7. The only extra parts you will need will be a zippy box and a 9volt battery.

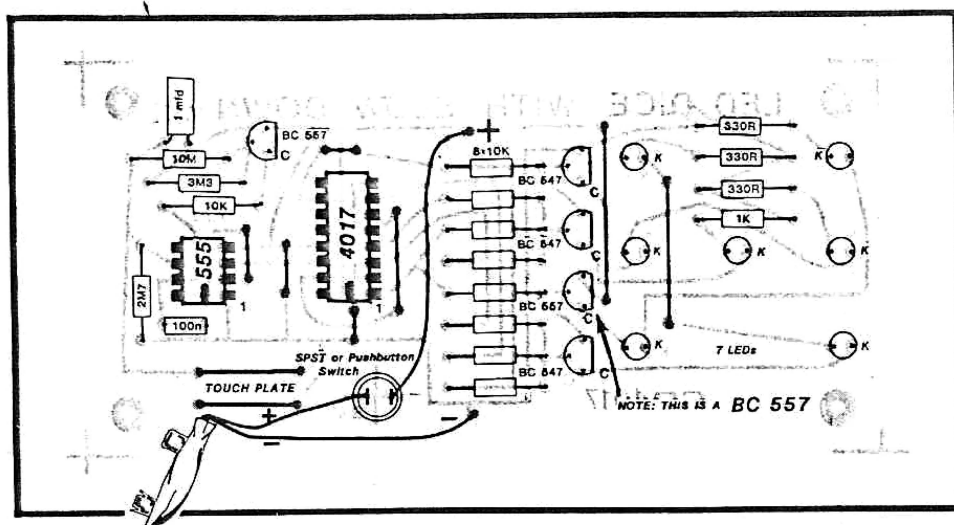
The way in which the circuit works is very ingenious. When you touch the TOUCH PLATE WIRES, the LEDs start flashing in a similar manner to a dice rolling over and over. This gradually slows down to rest on a number which is displayed exactly like the dots on a dice. This "illuminated dice" effect has fascinated

me ever since I saw it on an animated display near a busy city junction. It showed a pair of brightly lit dice tumbling over and over and finally coming to rest on a randomly selected number. An apt caption below the neon sign read "DON'T GAMBLE, USE SHELL" Unfortunately the sign was pulled down to make way for road widening and I don't think it has appeared elsewhere. In those days, whenever I passed, I had a personal bet as to which number would come up next. I don't think I ever won, even though the chances were just 36:1. With the passage of 20 years, the mechanics and electronics of this display can be reduced to a couple of IC's and a handful of parts. I hesitate to think how many switches and relays were used in the original design.

As we have mentioned before, the operation of the circuit is quite ingenious. We have programmed the first six outputs of a DECADE COUNTER to light various combinations of LEDs. These LEDs are arranged at one end of the PC board to form the dot layout of a normal dice. One extra LED is placed in the centre to create "one" and "five" patterns. Instead of sequencing each output to correspond to one, two, three etc on a dice, we have jumbled up the sequence to simulate the rolling of a real dice.

The first unusual feature you will notice with this circuit lies in output pin 2. It seems to go nowhere. Only after examining the make-up of the numbers 1, 2, 3, 4, 5, 6 will you notice that the LEDs representing





the number 2 are also used for 3,4,5,6. The only time when they are extinguished is for the number 1. We have used this knowledge to reduce the number of components. The next important feature involves the buffer transistors. They are necessary to drive the LEDs adequately to obtain maximum brightness. We found it impractical to drive the LEDs directly from the output of the CD 4017, especially when a number of LEDs were to be illuminated.

The 10k resistors have a dual function. They are used partially as gating and partially for current limiting to the base of the transistors.

Take for instance, pin 1 of the CD 4017. When it is HIGH, it will turn off the upper BC 557 via the top 10k resistor and will allow sufficient current to flow to achieve this. Also connected to pin 1 are three other 10k resistors and we must work out the resulting voltage which will appear on the output of this combination if say 8v is present on pin 1. By simply calculating the value of these resistors in series/parallel we find the voltage is about one-third of pin 1 voltage or about 2.6 volts. This is adequate to turn on the transistor driving the single LED number 4. (In actual practice you will find the voltage will have dropped

to the full turn-on voltage of about .6 to .7v.) When output pin 2 goes HIGH, the only LEDs to be illuminated will be 2 and 6. This represents the number 2 on the dice.

The rest of the circuit is fairly straight-forward. It comprises two building blocks from the previous project. We have found these to operate most successfully.

## Testing The Unit

Connect the battery and you should see a number of LEDs light up. Place your finger on the TOUCH PLATE and all the LEDs will appear to be lit. They will gradually slow down to a flicker and finally come to rest. This is the normal action of the project but sometimes things don't work out quite so simply.

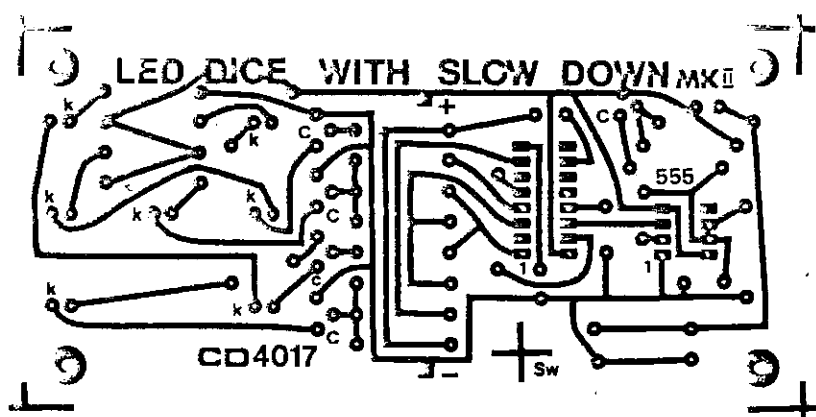
There are 3 possible areas of faults.

1. The slow down section,
2. The oscillator section,
3. The counter and readout section.

Without any test equipment it is only possible to test these three sections by starting at the display end and working back to the slow-down stage.

## Parts List

R1	resistor	10M	$\frac{1}{4}$ watt
R2	"	3M3	"
R3	"	4M7	"
R5	"	10k	"
R6	"	10k	"
R7	"	10k	"
R8	"	10k	"
R9	"	10k	"
R10	"	10k	"
R11	"	10k	"
R12	"	10k	"
R13	"	1k	"
R14	"	330R	"
R15	"	330R	"
R16	"	330R	"
C1	capacitor	100n	100v
C2	electrolytic	1mfd	16v
Q1	transistor	BC 557	
Q2	"	BC 547	
Q3	"	BC 547	
Q4	"	BC 547	
Q5	"	BC 557	
IC1	timer	NE 555	
IC2	decade counter	CD 4017	
LED 1 - 7 5mm red LEDs			
battery snap switch			
9v battery			
"LED DICE WITH SLOW DOWN"			
PC BOARD			



The printed circuit board has been designed to fit exactly on top of a UB 3 Zippy or Jiffy box. The corner holes take self-tapping screws which fit into the moulded pillars.

All that will be contained inside the box is a 9v battery.

Before soldering any components, make sure the board fits neatly over the Zippy box opening. Trim the sides of the board with a fine file or sandpaper, to give it a neat fit. Open out the four corner holes to take self tappers. Begin construction by mounting the resistors, capacitors and transistors. Note: a BC 557 fits between the set of BC 547 transistors. You will also need to take

## Mounting The Parts

If the LEDs do not begin to flash when you touch the TOUCH PLATE, you will need to isolate the fault by removing pin 3 of the oscillator from the input clock of the CD 4017 and manually clock the IC with a 10k resistor connected to positive. This should make the LEDs change from one state to another.

Next re-connect the output of the 555 and bridge Q<sub>1</sub> with a 10k resistor. This will make the 555 clock the counter fairly quickly. If this does not happen, check the 555 and the capacitor. To test the slow-down circuit, short out the two TOUCH PLATES with a wire link to produce a very fast changing display. If this has no effect, check the BC 557 and its surrounding components.

If one or more LEDs do not light up, check their orientation or swap them over with some of the other LEDs. With this method you will gradually "home-in" on the fault.

care when inserting the LEDs. All the cathodes of the LEDs face towards one direction excepting one. LED 2 is positioned around the other way. Every thing else is fairly straight-forward. The layout of the board is fairly open and the parts are neatly laid out. The TOUCH PLATE consists of two parallel wires fitted over the top of the board like two staples. The on/off switch can either be a press-on switch or a single pole single throw switch. If a push button is used, you can use it to clock the CD 4017 display and this will show a random number without having to wait for the slow-down.

The integrated circuits are now fitted. You can use sockets or mount them directly on the board. Finish assembly with a battery snap and add a 9v battery.

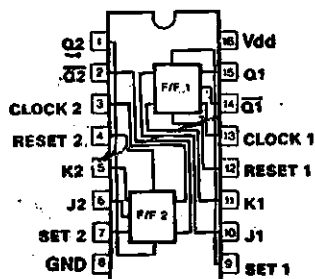
Drag out your old MONOPOLY game. This LED DICE will add new enthusiasm to playing the game. It may even bring you better luck than a couple of dice.

## Quiz:

by Craig Jones

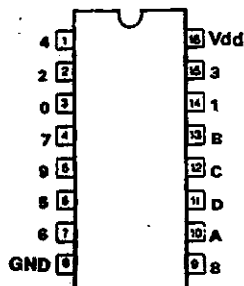
1. What does BCD stand for?
2. Which segments of a 7 segment display would be illuminated for the number 4.
3. Draw the circuit for a simple bistable switch using a CD 4001.
4. Which way do electrons flow through a diode?
5. What is a 74C85?
6. What is 4-bit word?
7. How many ways can a 4-bit word be expressed?
8. What is 4511?
9. What is a pi filter?
10. How many mfd/amp do we use when designing power supplies?
11. Which is more efficient: half-wave rectification or full wave rectification?
12. What is the voltage drop across a silicon diode?
13. Don't get fooled by this one . . . using only a multimeter, how do you detect the difference between a 74C85 and a CD 4024, if the numbers are rubbed off?
14. Why are voltage dividers inefficient?
15. Describe the operation of a full wave bridge rectifier.

### CD4027B



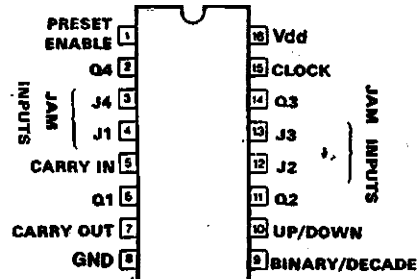
DUAL J-K MASTER/SLAVE FLIP FLOP WITH SET AND RESET

### CD4028B



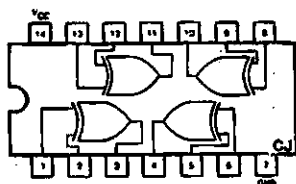
BCD TO DECIMAL DECODER

### CD4029B



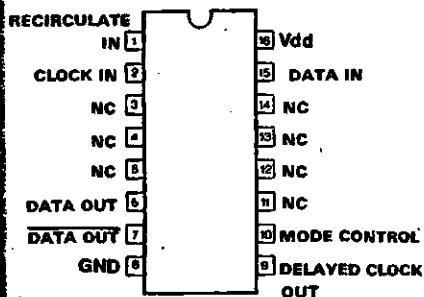
PRESETTABLE BINARY/DECADE COUNTER

### CD4030B



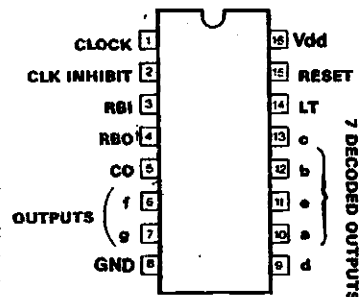
QUAD EXCLUSIVE - OR GATE

### CD4031B



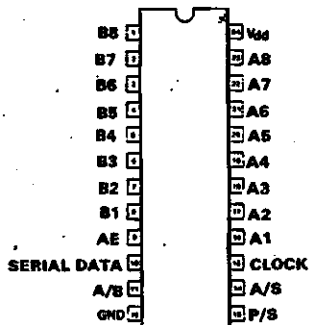
64-STAGE STATIC SHIFT REGISTER

### CD4033B



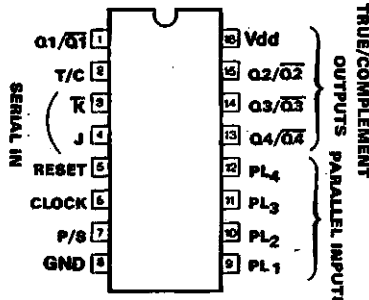
DECADE COUNTER DIVIDER

### CD4034B



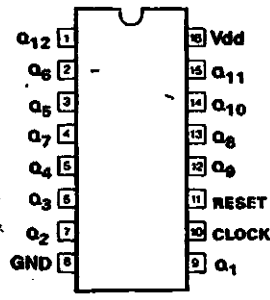
8-STATE TRI-STATE BIDIRECTIONAL PARALLEL/SERIAL INPUT/OUTPUT BUS REGISTER

### CD4035B



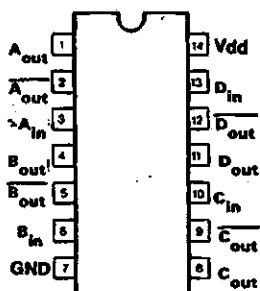
4-BIT PARALLEL-IN/PARALLEL-OUT SHIFT REGISTER

### CD4040B



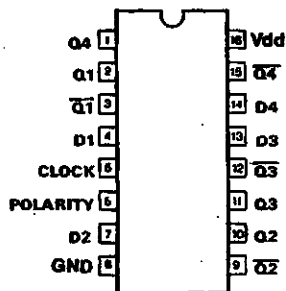
12-STAGE RIPPLE CARRY BINARY COUNTER

### CD4041CN



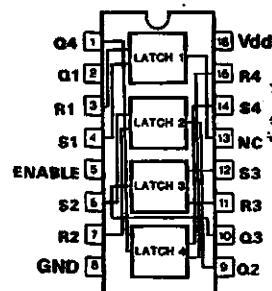
QUAD TRUE/COMPLEMENT BUFFER

### CD4042B



QUAD CLOCKED D LATCH

### CD4043CN



QUAD TRI-STATE NOR R/S LATCHES